DISORDERS OF THE BLOOD.

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THIS LITTLE VOLUME

IS

MOST RESPECTFULLY DEDICATED,

AS AN EXPRESSION OF GRATITUDE FOR

THE BENEFITS DERIVED FROM THEM,

By

THE TRANSLATOR.

THE TRANSLATOR'S PREFACE.

THE ARTICLE *"Störungen der Blutmischung"* which I have attempted to translate into English in the following pages, constitutes the Fourth Section of Virchow's *"Handbuch der speciellen Pathologie und Therapie,"* a work already too well known to the Profession to require any formal account. It contains a comprehensive, lucid, and accurate exposition of the Blood-diseases, and affords a clear and definite idea of the present state of our knowledge regarding them. It forms, in fact, an important and useful Monograph on the subject, and, as such, fully sustains the distinguished reputation and high position of the Author.

As regards the translation, I am fully conscious of its numerous imperfections. It has no pretensions to literary excellence. In its preparation the great object I had always in view, was a faithful rendering of the Original, and if I have succeeded in attaining that object, I shall deem myself amply rewarded.

In conclusion, I beg to express my deep obligations to Dr. Thomas Thomson and Dr. Georg von Liebig, for the great care and kindness with which they have revised the proof-sheets during their passage through the press, without which the translation would have been, in many respects, more defective than it is at present. My warm acknowledgments are also due to Dr. F. J. Mouat, for valuable assistance during the progress of the work.

<div align="center">CHUNDER COOMAR DEY.</div>

RISHRA : June, 1856.

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DISORDERS OF THE BLOOD.

§. 1. THE blood constitutes the centre of the whole metamorphosis of tissue in the body. Into it pass all nutritive materials after they have been more or less altered by digestion, etc. ; from it take place all secretions. The blood is, further, the medium of the respiratory process, the source of all nutrition and new formation. Hence the changes of the blood have an important influence upon all these organic processes, and, through them, upon the entire organism.

By the above-mentioned processes the blood is constantly changed, even in the healthy organism. But most of these changes are transitory, and rapidly removed ; and hence do not give occasion to disease.

In other cases, the changes in the blood are either more important, or more persistent. They then disturb the functions of other parts of the organism, and produce disease.

§. 2. As the blood traverses all the organs of the body, and exercises a great influence upon their functions, it is quite self-evident that the blood-diseases almost never run their course purely as such, but that other organs more or less sympathise with each of them. Hence the separation of the blood-diseases from other affections becomes very difficult, in many cases almost arbitrary.

In a great number of cases of disease, we may for many reasons conclude that the blood has undergone changes, and that these changes play a part in the disease ; but, in most cases, we as yet know these alterations in the blood incompletely, at all events, much less than other important elements of those diseases. This is, for instance, the case in the various kinds of poisoning, in many of which the blood is undoubtedly altered ; in many contagious, and miasmatic diseases—syphilis, scarlatina, measles, small-pox, malarious affections, typhus and other epidemic and endemic fevers, dysentery, etc. In all these cases, the blood is, no doubt, changed ; but of the mode in which this change takes place, we, at present, know much too little, to be able either to explain thereby theoretically the origin and the course of these diseases completely, or to deduce therefrom practically important indications for their treatment. It is the less necessary to treat of these blood-diseases here, because they are described in other parts of the work *(Hand-Book of Special Pathology and Therapeutics)*.

But there are disorders of the blood, which have been demonstrated beyond doubt, which may be diagnosticated at the bed-side of patients, and with whose influence upon the rest of the organism we are acquainted, to a certain extent at least. These will be particularly treated of in the following pages. In conformity with the tendency of the work *(op. cit.)*, those will especially be considered, which may be recognised at the bed-side of patients, and treated, and which have therefore a clinical signification.

The changes of the blood, with which we are, as yet, positively acquainted, evidently form but a small portion of those that occur in Nature ; and the zealous working out of this important department must, I am convinced, constitute one of the main tasks of the immediate future. Hence I have not restricted myself to communicate here only what we know with certainty, but have also often, so far as it has appeared admissible within the limits of a compendium and manual, indicated those points, whose careful study promises to afford further explanations in Pathology and Therapeutics. Though from the nature of the subject, many of these indications, especially their selection from the existing endless mass of material not yet admitted into science and practice, must often bear a subjective character, I have yet always taken pains to proceed therewith as impartially as possible, and, wherever I have been obliged to substitute hypotheses for facts, so to enunciate them, that they are not only open to the test of observations and experiments, but even call for it.

Many diseases of the *metamorphosis of tissue* are most intimately connected with the disorders of the blood.   But for extraneous reasons I have preferred to describe most of them among the diseases of the uropoietic system, and to mention them briefly here only for the sake of the summary.

That they may be better reviewed, the anomalies of the blood have been arranged in the following groups :—

FIRST GROUP.

Changes in the (relative) amount, and in the properties of the normal blood-constituents.

Abnormal conditions of the *red* blood-corpuscles —increase, diminution, qualitative changes.

Abnormal conditions of the *colourless* blood-corpuscles (leukæmia.)

Abnormal conditions of the *fibrin*—increase, diminution, changes in it (inopexia.)

Abnormal conditions of the *albumen*—increase, diminution, changes in it.

Abnormal conditions of the amount of *salts, alkalies, fats*, and *extractive matters* contained in the blood.

SECOND GROUP.

Abnormal conditions of the quantity of the blood, fulness of blood (plethora), and deficiency of blood (oligæmia). As an appendix, the more compound forms, *anæmia* and *chlorosis*.

THIRD GROUP.

Abnormal accumulation of noxious matters in the blood.

Sugar in the blood.   Acid in the blood.   Uric acid, and oxalic acid.   Ammonia, sulphuretted hydrogen, and analogous substances.   Urea.   Biliary matter.   Foreign bodies in the blood.

As an Appendix, *Putrefaction of the Blood*, and *Pyæmia.*   Scurvy.

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FIRST GROUP.

CHANGES IN THE (RELATIVE) AMOUNT, AND IN THE PROPERTIES OF THE NORMAL BLOOD-CONSTITUENTS.

HISTORY. LITERATURE.

§. 3. We naturally possess a more accurate knowledge of this group of changes in the blood only since the time when the amount, and the properties of the individual blood-constituents began to be more minutely studied, than had been the case before. During the last thirty or forty years, many zealous investigators have been at work in this department in Germany, England, and France. Of the independent works and important memoirs on this subject, the following deserve special notice :—

Hewson, experimental inquiries into the properties of the blood, 1774 ; *Thackrah,* an inquiry into the nature and properties of the blood, 1819 ; *Scudamore,* an essay on the blood, 1823 ; *Steveus,* observations on the healthy and diseased properties of the blood, 1832 ; *H. Nasse,* das Blut, 1836 ; *Lecanu,* études chimique sur le sang humain, 1837 ; *Denis* essai sur l'application de la chimie à l'étude du sang de l'homme, 1838 ; *Andral* and *Gavarret,* in Annales des sciences naturelles, 1841. Translated into German by Walther, Nördlingen, 1842 ; *Andral,* essai d'hematologie patholog., 1843.

Translated into German by Herzog, 1844 ; *Becquerel* and *Rodier*, numerous works upon this subject ; *Popp*, Unters. über d. Beschaffenh. des menschl. Blutes in verschied. Krankheiten, 1845 ; Wunderlich, patholog. Physiologie des Blutes, 1845; *Zimmermann*, ueber die Analyse des Blutes, 1847, besides numerous memoirs by the same author in various Journals; *C. Schmidt*, Charakteristik der epidemischen Cholera, 1850.

§. 4. The numerous analyses of the blood, which have been made during the last thirty or forty years, especially after the example of Andral and Gavarret, have almost all been confined to the establishment of the *percentage* of some of its main constituents. Many important facts, as regards Clinical Medicine, have been thereby obtained ; but, on the whole, the results, arrived at in this way, have neither answered our expectations, nor corresponded to the time and labor devoted to the investigations.   It is important, even for practical men, to know the causes of this partial failure, and to learn to avoid the various errors that have been committed.   They are chiefly as follows :—

In the first place, these investigations, from the manner in which they are usually made, rather mechanically* than with scientific precision, embrace only a small portion of the possible, nay even of the already actually demonstrated, anomalies of the blood. The increase and the diminution of the corpuscles, of the fibrin, albumen, and water of the blood, which are deemed by many pathologists the only, or, at least,

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* Literally, in the way of craft (handwerksmässig).

the most important disorders of the blood, form such a small part of this great subject, that the practitioner, and the clinical physician find, in a system of blood-diseases, based upon that restricted view, neither the necessary material for the diagnosis, nor for the treatment of the cases of disease that occur to them.

A further reason why these investigations have found less access into medical practice than is really due to them, lies in the *methods of analysis* hitherto employed. These are, in part, inexact and defective, as in the case of the quantitative determination of the blood-corpuscles ; and they are, moreover, almost all of such a nature, that practical and clinical physicians can make nearly no use of them. The methods of investigation, ordinarily practised, are so minute and laborious, and take up so much time, that the physician rarely determines to undertake an analysis of the blood, and, even when he has a chemist by his side to perform the analysis for him, he obtains its results, usually only after several days, so that their employment for therapeutical purposes is rarely possible, in acute diseases at least. Hence it is highly desirable, that methods of blood-analysis be invented, so simple, that every physician may employ them, if necessary at the bed-side of patients ; and that thereby the wished-for result may be obtained in a short time, in a few minutes, or, at most, in from a quarter to half an hour. I have taken much pains to invent such methods, and shall, in the following pages, communicate some of them, which have already

been so far developed, that they admit of a practical application.

There is still another circumstance, which renders it dangerous to infer at once a blood-disease from every variation in the composition of the blood found by analysis. The blood is very variable in its composition, and in a state of ceaseless change. It constantly gives off materials during the metamorphosis of tissue in each individual organ, especially in the organs of secretion, the kidneys, the liver, the intestine, the skin, and the lung ; but it, likewise, constantly absorbs substances from the food and the drinks that are introduced into the stomach and intestines ; from the secretions of the liver, the intestines, and the pancreas ; from the chyle and the lymph ; nay, from every individual part of the body during the transformation of tissue. Hence we must conclude,—and direct investigations raise this conclusion into a certainty—, that not only is arterial different from venous blood, but that the blood of each organ has a peculiar, more or less different composition. Any specimen of blood, obtained by venesection or in any other way, does not therefore express, accurately speaking, the average composition of the *entire* blood-mass, it shews only the composition of the blood contained in the part from which it is taken.

This evil is, indeed, lessened by the circumstance, that most specimens of blood, which are analysed, are obtained by venesection from one and the same part of the body, from a vein of the arm. But, even if we put aside these differences in the composition

of the blood of the individual parts of the body, and assume that every specimen, which is analysed, indicates the average composition of the whole blood, there is still another circumstance to be considered, which warns us to draw only cautious conclusions as to blood-diseases from deviations shewn by analysis : viz., that the composition of the blood may be temporarily altered by *physiological* influences. Each glass of water that is drunk and rapidly absorbed, renders the blood, at the time, richer in water ; while, on the contrary, after long-continued thirst, during which watery secretions have been separated from the blood by the kidneys, the skin, and the lungs, the amount of water in the blood is temporarily diminished ; by the copious use of common salt, the amount of common salt in the blood may be raised in an instant, and so forth. Hence, in many cases, it is difficult to decide whether a deviation from the normal composition of the blood, found by analysis, is pathological, and indicates a blood-disease, or only physiological, *i. e.*, such as would be again removed, in a short time, by physiological processes, and, therefore, demands no therapeutical interference. But these physiological variations of the blood are fortunately restricted within tolerably narrow limits, and we are quite justified in inferring an actual pathological disorder of the blood, whenever its quantitative composition, found by analysis, differs *considerably* from the healthy standard. To facilitate such conclusions, and to caution against deceptions, the limits of these

physiological variations, so far as they can be determined, are stated under the head of each constituent.

§. 5. Though the *qualitative* deviations of the several blood-constituents—the alterations in their properties—have hitherto met with much less consideration in Practical Medicine than their *quantitative* deviations, yet the great practical importance of many of them may be demonstrated, and that of still more, conjectured. It has appeared especially desirable to indicate here those points, whose further prosecution promises to be useful to Pathology and Therapeutics.

The blood-constituents, which will be considered in the following sketch, are :—

1. The *blood-corpuscles*, the red as well as the colourless.

2. The *liquor-sanguinis*, its fibrin, albumen, salts, extractive matters, and fats.

1. ABNORMAL CONDITIONS OF THE BLOOD-CORPUSCLES.

A. OF THE RED.

§. 6. The red blood-corpuscles of man, form, as is well-known, round little discs, or vesicles (cells ?), with cup-shaped depressions on both surfaces, whose diameter is estimated at about $\frac{1}{3000}$ — $\frac{1}{4000}$ of an inch. They are present in the blood in an immense number. In the adult healthy man, their number is estimated

at about sixty billions ; and, in the female, at some-
what less. They are very complex in their chemical
composition, and consist of globulin, hæmatin, va-
rious salts, phosphate of potash, iron, etc.

Of their function, and their signification as regards
the vital process, we know only so much, that they
are the special, perhaps the exclusive, medium of
the respiratory process. They absorb oxygen in the
lungs, convey it to the individual parts of the body,
and in the capillaries exchange it for carbonic acid,
which they again give off in the lungs.

This respiratory function of the blood-corpuscles is
of the highest importance to the metamorphosis of
tissue, and the vital process. It cannot be long inter-
rupted without endangering life. The nervous and
the muscular system appear to be first, and pre-emi-
nently affected by its disturbance.

Further, the globulin of the blood-corpuscles pro-
bably plays an important part in nutrition, and new
formation. Its quantity is greater than that of all the
remaining protein-substances together.

Regarding the formation and decay of the blood-
corpuscles we know little that is certain. Some
important practical questions connected with them
will be hereafter touched upon.

The abnormal conditions of the red blood-corpus-
cles, which are to be especially considered, in the pre-
sent state of special Pathology and Therapeutics, are
their increase and diminution, and alterations in their
properties.

INCREASE AND DIMINUTION OF THE RED BLOOD-
CORPUSCLES.

§. 7. The increase of the red blood-corpuscles (po-
lycythæmia*), as well as their diminution (oligocy-
thæmia), may be either *relative,* or *absolute.* The
relative refers to the percentage of corpuscles in the
blood ; in the absolute, the whole amount of blood-
corpuscles, contained in the body, is either increased,
or diminished. The distinction into these forms is
no logical subtlety—it has a great practical interest.

§. 8. The relative forms of polycythæmia and
oligocythæmia may be demonstrated and diagnos-
ticated by exact methods ; the demonstration of
the absolute forms has not yet been possible in
the living subject with the same certainty, and,
in their determination, we must content ourselves
with approximate estimates. The methods are as
follows :—

a. The *chemical investigation* of the blood.† Ac-
cording to any one of the well-known methods of

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* I have several times found myself obliged to coin new names,
as it is a great convenience to employ one word to denote a scien-
tific idea, instead of a long periphrasis. The above expressions sig-
nify only an increase, and a diminution of the blood-corpuscles gene-
rally, not of the red ones in particular. But, as the names poly*ery-
thro*cythæmia and oligo*erythro*cythæmia are too uncouth, and for the
increase of the colourless blood-corpuscles the words leukæmia and leu-
cocythæmia have already been adopted, so that no confusion can take
place in this respect, I have proposed those shorter terms.

† For the minutiæ of the usual methods of determining the blood-
corpuscles quantitatively, *Vide : Andral* and *Gavarret,* Untersuchungen

quantitative analysis of the blood (Andral and Gavarret, Simon, Figuier, etc.), the amount of dried blood-corpuscles, contained in 1,000 parts of blood, is determined, and the quantity, thus found, compared with the normal standard. According to Becquerel and Rodier, this is estimated at :—

	Mean.	Minimum.	Maximum.
In the male, ...	141	131	152
In the female, ...	127	113	137

According to Andral and Gavarret, the quantity is somewhat less, which is due to the circumstance, that these investigators have made no distinction between the two sexes. They regard 127 as the general mean, 110 as the minimum, and 140 as the maximum.

If, in a specimen of blood that is being investigated, the amount of blood-corpuscles exceeds the normal maximum, a relative increase of the corpuscles (relative polycythæmia) is present ; if it, on the contrary, falls below the normal minimum, a relative diminution of the corpuscles (relative oligocythæmia) exists.

There is a great want of *precision* in this chemical determination of the blood-corpuscles, for instance, the method usually practised, (that of Andral and Gavarret), involves such sources of error that mistakes of five per cent. and even more may occur. Further,

über die Veränderungen der Mengen-verhältnisse des Faserstoffes, der Blutkugelchen, etc. Annales des sciences naturelles, 1841. Translated by A. Walther, Nördlingen, 1842 ; *Becquerel* and *Rodier*, Untersuchungen über die Zusammensetzung des Blutes, etc. Gazette Médicale de Paris, 1844. Translated by Eisenmann, Erlangen, 1845; also *Höfle*, Chemie und Mikroskop am Krankenbette ; and *v. Gorup-Besanez*, Anleitung zur qualitativen und quantitativen zoochemischen Analyse, Nürnberg, 1850.

only the analyses instituted according to one and the same method, can be compared with each other. The methods of Simon, and of Figuier, yield still less accurate results. Moreover, all these chemical modes of determining the blood-corpuscles are very laborious and minute, on account of the repeated necessity there is for drying and weighing ; and it is a long time, generally several days, before the result is obtained. Hence all these methods are very ill-adapted for practical purposes, and have hitherto met with almost no application in medical practice.

b. H. Nasse has stated a method of determining the amount of blood-corpuscles in the blood, which is somewhat more convenient in practice.* He determines the specific gravity of defibrinated blood, as well as that of the serum, and from the difference between the two specific gravities, estimates the amount of corpuscles in the blood, according to a somewhat complex formula. The error-limits of this method have not yet been precisely made out, but are scarcely greater than those of direct analysis, as it is usually performed. This method, also, yields no instantaneous result ; we must wait until the necessary amount of serum has separated, and require a tolerably large quantity of blood (six to eight ounces) for its performance.

c. Counting the blood-corpuscles, as proposed by Vierordt and Welcker.† The blood-corpuscles

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* Archiv des Vereins für gemeinschaftl. Arbeiten, Vol. I, Part III.

† *Vierordt*, Various memoirs in Archiv f. physiolog. Heilkunde, 1852 ; *H. Welcker*, Archiv des Vereins f. gemeinsch. Arbeiten, Vol. I, Part II.

contained in a certain accurately measured volume of blood, which has been diluted with a definite proportion of salt-water, are counted, and from it is calculated the number of corpuscles that are contained in a cubic millimetre* of the blood under examination.

But, according to Welcker's calculations, one cubic millimetre of blood, at 63°.5 Fahr., contains, in the normal condition, blood-corpuscles in the following numbers :—

	Mean.	Minimum.	Maximum.
In the male,	5,000,000	4,500,000	5,500,000
In the female,	4,500,000	4,000,000	5,000,000

If the number of blood-corpuscles in the cubic millimetre exceeds, in the male, $5\frac{1}{2}$ millions, and, in the female, 5 millions, it indicates relative polycythæmia; if it is below $4\frac{1}{2}$ millions in the male, and below 4 millions in the female, relative oligocythæmia.

According to the method developed by Welcker, this process is so sure, that any tolerably experienced person obtains, at least, an equally trustworthy result as by chemical analysis. The error-limit rarely exceeds 1 to 2 per cent. ; and one to three hours are enough for completing such an enumeration. Also, only a very small quantity of blood is necessary for it ; the contents of a single cupping-glass being more than sufficient. Notwithstanding these and other advantages over chemical analysis, the counting-

* A millimetre = .039371, or a little less than $\frac{1}{25}$ of an inch.

process is still too laborious and detailed to find its application in medical practice, except in individual cases.

d. Determination of the *amount of hæmatin* from the *colour* of the blood, by means of the blood-colour-scale, mentioned by Welcker.* A certain precisely measured-off volume of blood is diluted with a definite quantity of water (1,000 times the volume of the blood), and the colour of the mixture compared with the colour of the scale, which consists of many divisions, and has been made by mixing blood and water in different proportions. The amount of blood-corpuscles or hæmatin, corresponding to each division of the colour-scale, must be previously ascertained by counting, or by chemical analysis.

By this method the amount of red corpuscles in the blood is not directly obtained, but only that of the *blood-pigment.* But as in the infinitely great majority of cases, the amount of blood-corpuscles and of hæmatin in the blood rises and falls in the same proportion, this method may also be applied to the determination of relative polycythæmia and oligocythæmia. Its results are sufficiently accurate, at least, equally so with those of chemical analysis ; a small quantity of blood is necessary (the contents of a single cupping-glass being enough) ; and, what is the main thing, the whole investigation is completed in a very short time, in about five minutes,

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* Archiv des Ver. f. gem. Arbeiten. Vol. I, Part II.

and requires, for its performance, no complicated apparatus, nor any particular skill. As a carefully made colour-scale, though troublesome in preparation and adjustment, continues serviceable for months, this method is a really practical one, which every practical, at least every clinical, physician should employ in case of need.

§. 9. By the methods described above, a *relative* increase or diminution of the blood-corpuscles may be demonstrated with certainty, and by the last even with ease. The case is different with the *absolute* increase, or diminution of the corpuscles. An exact determination of them is possible only in the dead subject; * as regards the determination in the living, we can only make approximate estimates. An *absolute increase* of the blood-corpuscles may be supposed to exist, if, in addition to a relative polycythæmia, the signs, to be hereafter described, of an augmentation of the mass of the blood (plethora) are present ; an absolute *diminution* of them, if, besides relative oligocythæmia, the phenomena of a general deficiency of blood (anæmia) are present ; likewise, if great losses of blood have taken place.

A considerable degree of relative increase, and especially of diminution of the corpuscles may also be generally associated with an absolute increase or diminution of them ; a relative increase of the

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* I shall communicate the methods necessary for the purpose in one of the next Parts of the Archiv des Ver. f. gemeinsch Arbeiten.

blood-cells may, however, be counter-balanced by a simultaneous diminution of the entire blood-mass, and, *vice versâ,* a diminution of the corpuscles, by an increase of the mass of the blood ; so that we must be cautious in drawing such conclusions.

The following considerations may afford a measure of how far a relative polycythæmia and oligocythæmia may be produced by transitory physiological conditions, and shew whereabouts lies the limit between such physiological variations, and the true pathological abnormal conditions.

If we assume, that the whole amount of blood, in an adult healthy man, is estimated at 12,000 grammes* (24 ℔s.), and that it contains, according to Becquerel and Rodier, 140 parts of dry corpuscles in 1,000 parts, the weight of the latter in the entire blood-mass will amount to 1,680 grammes.

If we further assume, that the above person takes as much water as increases the amount of his blood by 1,000 grammes ; an assumption, which exceeds, at all events, the possible limits, since 1,000 grammes, (=1 litre)† of water can hardly pass into the blood, without a portion of the surplus water being again separated by the kidneys, the lungs, and the skin. We then obtain the following proportion : the whole amount of blood is now estimated at 13,000 grammes ; but there are contained in this, as before, only 1,680 grammes of blood-corpuscles, *i. e.,* about 130 in 1,000 parts.

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* A gramme = 15.43 grains.
† A litre = a little less than two pints.

If we take the opposite case, and assume that, in the same person, 1,000 grammes of water have been removed from the blood by the secretions, the sweat, the pulmonary exhalation, the urinary secretion, purging, &c., without any compensation having taken place for the same by drinks, &c., while the mass of the blood-corpuscles has remained unaltered. (This assumption is, also, probably too high, as in such a case, all the parts of the body would probably supply water to the blood, and dilute it; it therefore represents, at all events, the physiological extreme.) We should now have 1,680 grammes of corpuscles in 11,000 grammes of blood, consequently, 153 in 1,000 parts. But these numbers, 153 and 130, almost quite exactly coincide with those which Becquerel and Rodier have by analysis found to be the extremes of the physiological proportion.

The case is exactly similar with the numerical method, in which the volume of the blood-mass is considered, instead of its weight, and the number of the blood-corpuscles, instead of the weight of the same. If we assume the volume of the entire blood-mass, to take a round number, at 12,000 cubic centimetres,* or 12 millions of cubic millimetres,† and in each cubic millimetre 5 millions of blood-corpuscles, then the whole blood contains 60 billions of the latter. Were 1,000 cubic centimetres of water to pass into the blood, as above, the volume of the latter would rise to 13 millions of cubic millimetres, and in 1 cubic

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* A centimetre = .39371, or a little less than $\frac{2}{5}$ of an inch.

† *Vide* p. 16, Note.

millimetre there would now be contained only 4,600,000 corpuscles. On the contrary, were the volume of the blood to diminish in consequence of copious secretion, without any compensation taking place from the opposite process, and to sink to 11 millions of cubic millimetres, 1 cubic millimetre of blood would now contain 5,400,000 corpuscles.

The physiological variations between 4,600,000 and 5,400,000, estimated in this way, are somewhat less than the above-mentioned physiological maxima and minima, obtained by direct observations.

§. 10. The *results* of an increase, or diminution of the blood-corpuscles, so far as they are yet known, may be explained by the functions of these structures, described above.

An *absolute increase* of them causes increased absorption of oxygen and increased metamorphosis of tissue corresponding to it, as well as greater production of heat ; it augments the energy of the muscular system, of the heart, and of the nervous system. In persons suffering from it, a tendency to congestions in various organs, and to haemorrhages is very frequently observed ; but whether this depends upon the polycythæmia, or upon the vascular over-distension (plethora), commonly associated with it, cannot yet be decided with certainty.

A simple *relative* increase of the corpuscles, which does not much exceed the physiological maximum, appears to produce no important results. Extreme degrees of relative polycythæmia, as they sometimes

nutritious meat-diet, etc., with *good digestion* and *slight exercise.* An excessive use of ferruginous preparations, and of tonic medicines acts less decidedly. At the head of the predisposing causes stand youth, and a constitutional peculiarity,—a tendency to the formation of blood-corpuscles,—which has not hitherto been more minutely explained, and is, in many individuals, congenital, more rarely acquired.* In very intense cases, several of the above-named causes usually co-operate.

Relative polycythæmia may arise from the same causes ; yet its more severe forms are commonly produced by very copious watery secretions from the blood, by profuse diarrhœa, large exudations, cholera, etc., which remove from the blood such an amount of the constituents of its serum, that the remaining corpuscles form a much larger percentage in it than in the normal condition.†

An *absolute diminution* of the blood-corpuscles is always caused by an excess of their disintegration over their new formation, either from increased decomposition, or from restricted new formation, or from a combination of both. The proximate causes are here also generally unknown to us. It is true, that we know a number of

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* In many persons, the red blood-corpuscles appear to form more easily and rapidly from the other blood-constituens (albumen, etc.) than in others. The conditions, and the proximate causes of this increased tendency to the formation of blood-corpuscles are, as yet, unknown.

† *Lecanu,* études Chimiques sur le Sang Humain, 1837 ; *C. Schmidt,* Characteristik der epidemischen Cholera, 1850 ; Piory, Blutkrankheiten. Translated by Krupp, 1848, p. 100, et seq.

substances, which, being brought into contact with the blood, outside the body, rapidly destroy the red corpuscles; but only a few of them seem capable of occurring in the living body in disease.* We are better acquainted with the remote, and promoting causes. Of those, which act by an inordinate diminution of the blood-corpuscles, are to be named, above all, copious or oft-repeated abstraction of blood and hæmorrhages; further, increased consumption of blood-corpuscles by strong exercise, severe corporeal and mental labour, care, grief, and many diseases. Defective nutriment containing little protein, anti-phlogistic modes of cure, and disordered digestion, act by deranging the new formation of blood-corpuscles. Very frequently, several of these causes co-operate—losses of blood, increased disintegration of the corpuscles, and disordered digestion.†

* For various reasons, more minutely detailed in the following sections, the diminution of the blood-corpuscles may be arranged in two classes, whose distinction has a practical importance.

1. The blood-corpuscles diminish simultaneously with the remaining blood-constituents, when a loss of blood takes place, either directly or indirectly, and the supply of nutritious substances to the blood, and consequently sanguification, is generally diminished.

2. The blood-corpuscles diminish in a greater proportion than the other blood-constituents, and relative oligocythæmia arises. This takes place either because the blood-corpuscles are consumed in a greater measure than the other blood-constituents by active agents, or because the other blood-constituents (albumen, fibrin, colourless corpuscles) are formed abundantly, even to excess, from the alimentary substances, while the formation of blood-corpuscles from these materials remains defective for reasons which are not sufficiently clear.

† For particulars upon this subject, *vide* §. 21, under the head of " Dissolution of the Blood-corpuscles."

§. 12. *Occurrence and complications.* Polycythæmia and oligocythæmia, especially the latter, very often occur, associated ordinarily with other changes in the blood, but rarely in a pure form. Polycythæmia has been identified with plethora (Andral and Gavarret) ; and oligocythæmia is almost generally considered as identical with anæmia. Both views are incorrect (*vide* the sections on Plethora and Oligæmia), and it is absolutely necessary to distinguish these conditions accurately from one another, if it is wished to obtain a clear insight into such complicated disorders of the blood.

Absolute polycythæmia has hitherto been scarcely demonstrated with certainty ; it is only probable that it occurs in persons, who, besides relative polycythæmia, present the phenomena of so-called plethora. It involves neither a positive disease, nor a disposition to disease, and is met with more frequently in the healthy than in the sick, more frequently at the beginning of a disease than after a longer duration of it.

Relative polycythæmia, in a slight degree, is found occasionally in the plethoric, and at the commencement of febrile diseases. The higher degrees, as mentioned before, occur only after copious watery secretions from the blood. They are, if death do not take place earlier, altogether transitory, as the lost liquor sanguinis is usually restored by the absorption of drinks, and by the resorption of fluid from all parts of the body.

Oligocythæmia has much more frequently been demonstrated with certainty. It forms an essential,

or a very rarely absent, element of the morbid conditions, described under the names of anæmia and chlorosis; and occasionally accompanies even plethora (plethora serosa). We find it in the latter stages of almost all acute and of many chronic morbid processes, in short, in all cases, where the consumption of blood-corpuscles has been increased, or their new formation checked, for a long time. The highest degrees are observed after very copious or oft-repeated losses of blood.

It enters into the most various complications. Besides those already mentioned with anæmia and plethora, the most important are those with leukæmia, with hyperinosis, and with hydræmia.

§. 13. *Therapeutics.* A rational treatment of these conditions is rendered difficult by the circumstance, that occasionally the diagnosis is not certain, when the physician will not, or cannot, undertake an investigation of the blood ; still more frequently because the causes are not well-known, or, if well-known, cannot be removed.

Absolute polycythæmia is most rapidly obviated by *abstractions of blood.* General and local abstractions of blood act equally well in this respect—success depends only on the *amount* of blood that is drawn. But abstractions of blood have merely a palliative effect, the condition returns, if the causes, which produced it, persist. Though the favorable effects of venesection usually continue longer in polycythæmia than in any other abnormal condition of

the blood (plethora, hyperinosis, hyperalbuminosis), as the blood-corpuscles are more slowly restored than the other blood-constituents; yet, to cure the condition radically, we must seek to remove its cause, or to increase the consumption of blood-corpuscles, and to diminish their new formation, in a lasting manner. This is done best and most harmlessly in a dietetic way, by an alteration in the mode of living—spare, rather vegetable diet, with simultaneously increased exercise in the open air. The same object is attained also in another way, by oft-repeated small abstractions of blood, or by artificial disorders of digestion, which are produced by the long-continued use of neutral salts, of nitrate of potash and soda, of sulphate of soda or magnesia, of bitartrate of potash, etc.—still such a course is not to be recommended, and must be adopted only in case of necessity, if the dietetic means are not applicable.*

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* Besides the means mentioned above, there are still many others which may counteract polycythæmia—active agents, which, when they come in contact with them, more or less rapidly destroy and dissolve the blood-corpuscles. We undoubtedly observe this, if we bring defibrinated blood in contact with various substances; while some substances preserve the blood-corpuscles unchanged, others dissolve them. But it is certain, that many substances exercise also this solvent influence upon the blood-corpuscles within the living body. Water, different acids, caustic and carbonated alkalies, arseniuretted hydrogen, sulphuretted hydrogen, nicotin, and many others, appear to have such effects. I have instituted numerous experiments upon this subject, which however have not yet extended so far, as to allow sure practical indications to be deduced from them. But the subject is very highly important. It is true, that we possess in venesection a sure and rapidly efficient means of checking a polycythæmia. But, if the tendency to it be a lasting one, as in habitual plethora, and in the so

The events, which often occur as results, or as complications of polycythæmia, demand a special consideration in the treatment. These are plethora, a tendency to congestions in different parts, and to hæmorrhages (which occasionally become critical, and remove the condition) ; excitement of the heart (palpitation of the heart, &c.), and of the nervous system (headache, mental irritability, and, as ulterior effects, depression of the activity of the brain—tendency to apoplexy). As, in most sufferers from polycythæmia, there exists a disposition to the symptoms named above, such individuals must avoid every thing that can stimulate the heart, the vascular system, or the nervous system ; such as stimulating, high-seasoned food and drinks, especially spirituous ; violent and stirring bodily exertions; exciting mental labour and emotions ; overloading the stomach, which stimulates the heart directly, by pushing up the diaphragm, and indirectly by the swelling of the spleen and the liver, consequent upon the overloading;

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frequently occurring hæmorrhoidal conditions, this means fails us, and repeated blood-lettings generally produce no other effect than to transform the polycythæmia into another form of disease, into serous plethora! To discover remedies, efficient and harmless as far as possible, for this frequently so obstinate a tendency to the increased formation of blood-corpuscles, is of the greatest importance in practice. Arseniuretted hydrogen gas appears to be such a remedy (compare my communication in the Archiv d. f. gemeinsch Arbeiten, (Volume I, Part II, page 209), but is too dangerous to meet with general application. Also, sulphuretted hydrogen seems to act in a similar way (compare Roth on the cold sulphureous water at the Weilbach watering-place, Mentz, 1847); yet further precise investigations upon this subject seem very desirable.

for the same reason any existing habitual constipation must be removed. If the above-mentioned events have actually occurred, they must be treated according to the therapeutical rules, applicable to each of those symptoms, yet with a constant reference to the polycythæmia, which is the fundamental disease.

For the removal of higher degrees of *relative* polycythæmia, blood-lettings have also been proposed, especially in cholera (C. Schmidt). Yet these will manifestly have no great effect, as long as the cause continues ; and, if this is removed, the diminution of the liquor sanguinis will rapidly be made good by the drink that is taken, or by the absorption of water from other parts of the body.

In *oligocythæmia*, the first and the most important task is to combat the cause, if it still continues. To this head belongs suppression of continued or frequently recurring hæmorrhages—improvement of bad or insufficient food—removal of disordered digestion, of care, grief, etc. The removal of the cause is occasionally enough to improve the condition of the blood in a short time.

In cases, where the cause cannot be discovered, or, if discovered, cannot be removed, we should seek to increase the new formation of the blood-corpuscles as far as possible. This is done by nutritious diet, especially meat-diet, red* roasted meat—in children, raw scraped beef—strong broths,

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* *i. e.*, Beef and venison, but not veal nor fish.

prepared according to Liebig's method,* with mode-
rate exercise and residence in pure air, besides, if it
agrees, the moderate use of beer and wine, especi-
ally claret.   Of medicines, tonics, bitter and bitter-
aromatic remedies, preparations of cinchona, but,
above all, *preparations of iron,*† aid the formation
of blood-corpuscles.   Yet all these remedies act very
gradually, after some days, or more frequently after
some weeks.‡   Where the diminution of the blood-
corpuscles, as is sometimes the case after great losses

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* Raw meat is minced as fine as possible, then treated with
cold water, and expressed after standing for some time.   The
fluid, thus obtained, is boiled, in order to remove the albumen,
skimmed, and, by skimming, freed from fat as far as possible, and
mixed with some salt and spice.   An equally strong broth is obtained
by the solution of extract of meat (but *not* of ordinary cakes of *bouillon)*
in warm water.

† According to my experience, the various chalybeates (powdered
steel, hydrated sesquioxide of iron, lactate of iron, the different tinctures
of iron, chalybeate mineral waters, etc.,) act equally favorably, and the
choice of a preparation, in any particular case, is determined by other con-
siderations, (the condition of digestion, the complications, and the like.)

‡ Corresponding to the two classes of oligocythæmia established
above (note to §. 11), two different therapeutical indications must also
be distinguished practically :

1. Where the blood-corpuscles have been diminished simultaneously
with the other blood-constituents, and the object is to restore the lost
or the diminished blood on the whole, the indication is to increase the
blood generally—by nutritious diet, preparations of cinchona, improve-
ment of digestion, etc.

2. Where, on the contrary, the formation of the blood-corpuscles is
alone diminished, while there is no want of nutritive material, and the
remaining blood-constituents are abundantly present, where, therefore,
only the intensity of the formation of the blood-corpuscles from the other
blood-constituents (albumen ?) seems diminished, the *preparations of
iron* appear to be especially appropriate.

of blood, is so considerable, that the remainder are not sufficient for the maintenance of the metamorphosis of tissue, and of life, the only efficient remedy consists in a direct introduction of blood-corpuscles into the vascular system by *transfusion.* This remedy itself is not, however, harmless, and must, therefore, be tried only in cases of urgent danger to life.

For the treatment of the events frequently accompanying oligocythæmia, of its results, and its complications, *vide* under the head of "Anæmia."

The question, whether an increase or diminution of the blood-corpuscles, and what degree of the latter, is present, is one which must be considered in practice, wherever it is to be decided, whether or not, for any reason, abstraction of blood should be performed.

Irrespective of indications and contra-indications present on other grounds, and notwithstanding the condemnation, pronounced by many physicians upon this mode of treatment, a blood-letting, even a large one, may be performed unhesitatingly, or at all events, without great injury, upon a person who is suffering from polycythæmia, or the amount of whose corpuscles is, at least, not strikingly diminished. Where, on the contrary, oligocythæmia, especially a high degree of it, exists, we should only then resort to a venesection, when very important reasons, deduced from other sources, render it indispensably necessary.

§. 14. The *prognosis* of polycythæmia and oligocythæmia is evident from the preceding account.

Polycythæmia involves in itself no great danger, and becomes only dangerous through its complications ; such as congestion in important parts, and hæmorrhage. Recent cases of it are, if the patients be well-disposed, curable ; those that are deep-rooted, and complicated with gout, hæmorrhoids, etc., are generally obstinate.

The more severe and rare forms of relative polycythæmia are probably not in themselves dangerous, but easily become so by the diseases which produce them.

The prognosis of oligocythæmia is determined by its cause, and its degree. In extreme cases, it may prove fatal. Chronic cases are generally complicated in their character, which circumstance has frequently an influence upon the prognosis.

QUALITATIVE CHANGES OF THE RED BLOOD-CORPUSCLES.

§. 15. As the blood-corpuscles are not simple substances, but tolerably compound structures, besides an increase or diminution of their number, there may, no doubt, take place many other disturbances in their composition,—increase or diminution of their individual constituents, of the hæmato-globulin, hæmatin, and the amount of phosphate of potash, etc., contained in them,—and alterations in their properties, and through them in their functions, etc. It cannot be doubted, that these disorders also produce pathological effects, and have therefore a practical importance. But as yet a dense veil lies over them, the little that we know of them is very hypothetical, and has, on

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that account, found no access into practice ; in short, the doctrine of these relations does not belong to the pathology of the present epoch, but to that of the future. The following communications are, therefore, chiefly intended to indicate the existence in this direction of numerous very interesting and important facts, which still remain undiscovered, so as to exhort physicians to a further prosecution of the subject.

CHANGES IN THE FORM AND SIZE OF THE BLOOD-CORPUSCLES.

§. 16. The blood-corpuscles undergo, as is well known, outside the body, in contact with other substances, many changes in their form and size. In fluids which are more diluted than the blood-plasma, they imbibe water by endosmosis, swell-up, lose their biconcave form, become globular, and at last burst. On the contrary, in fluids which are more concentrated than the plasma, they shrink and become smaller.

Owen Rees* has maintained, that such changes also occur in the living body. In persons who had lost much water by sweating during violent bodily exertion in summer, without the loss having been made good by drinking, he states that he found the blood-corpuscles very much shrivelled-up, exactly as if they had been treated with a concentrated saline solution. Rees further believes, that in anæmia (or rather in hydræmia) the blood-corpuscles are enlarged and

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* Gulstonian Lectures, delivered at the Royal College of Physicians. London Medical Gazette, March, April, 1845.

swollen, on account of the great abundance of water in the blood, so that they can no longer penetrate the capillaries of the skin and mucous membranes so easily as before , hence these parts appear pale. For the same reason, copious water-drinking is said to contribute to stop hæmorrhages from the capillaries, as the blood-corpuscles thereby swell-up and increase in size, and so block up the rents in the capillaries.

The occurrence of such changes in the form of the blood-corpuscles would pre-suppose changes in the degree of concentration of the liquor sanguinis, though they have not hitherto been observed in the living body ; and the alterations in form would by themselves alone occasion more important derangements of the circulation and the metamorphosis of tissue than the changes in the size of the blood-corpuscles.

It appears most advisable for Practical Medicine to take for the present no notice of these and other changes in the form and size of the blood-corpuscles, which some observers state that they have seen in disease.

DIMINISHED ABSORPTION OF OXYGEN BY THE BLOOD-CORPUSCLES.

§. 17. It is the blood-corpuscles in particular, which absorb oxygen in the lungs, convey it through the circulation to all parts of the body, and thereby render the metamorphosis of tissue possible. If this absorption of oxygen by the blood-corpuscles in the lungs is for any reason stopped or diminished,

arterial blood retains the properties of venous blood, and *cyanosis* arises. The highest degree of cyanosis, wherein the absorption of oxygen by the blood-corpuscles is completely prevented, has for its consequence an entire cessation of the metamorphosis of tissue, and, through it, death by asphyxia; but even moderate degrees of cyanosis give occasion to serious disturbances of health, so that this affection acquires a great practical importance.

§. 18. The *causes* of cyanosis are very various. They may be arranged in two great groups; in the one, the supply of oxygen to the blood, and consequently the oxidation of the blood-corpuscles, is prevented by derangements of the respiration, or the circulation, etc., in short, by causes, which lie external to the blood; in the other, the blood-corpuscles lose the property of absorbing oxygen. On account of the great practical importance of this subject, we shall consider here the most essential causes somewhat more in detail, although the first group of them does not, properly speaking, belong to the blood-diseases. Cyanosis arises :—

1. If, by any obstacle in the department of the *respiratory process*, the access of air to the blood in the pulmonary capillaries is prevented, or impeded. Such obstacles are closure or narrowing of the glottis by spasm, œdema, and croupous inflammation of it; closure or contraction of the trachea and bronchi by spasm, mucus, blood, foreign bodies, croupous membranes, and inflammatory

thickening of the mucous membrane; entrance of air into the pulmonary cells prevented or retarded by inflammatory or tuberculous hepatisation of the lung, by pulmonary œdema, and compression of the lung, by exudation in empyema and hydrothorax, by air in pneumothorax; respiration impeded or prevented by diseases of the thoracic parietes, of their nerves or muscles, and of the diaphragm, and by pulmonary emphysema; elevation of the diaphragm by enlargement of the abdominal organs, tympanitis, ascites, etc.

2. If, by any derangement of the circulation, the blood is prevented from circulating through the lungs, and from absorbing oxygen in them, in the same way as in the normal condition. To this head belong disorders of the heart's action, reduction of it to a minimum; obstruction of the pulmonary vessels by coagula, and other matters foreign to normal blood; stagnation of the blood in the lung (pulmonary stasis, hypostatic pneumonia), shrivelling-up of the pulmonary tissue, with partial obliteration of the pulmonary vessels; compression of the latter by exudations, etc.; direct passage of venous blood from the right into the left heart without its having passed through the lungs (by abnormal communication between the right and the left heart, patency of the ductus arteriosus Botalli and the foramen ovale after birth).

3. If the air, received into the lungs, contains no oxygen, or less than the proper amount of it (breathing in irrespirable varieties of gases, in carbonic acid, and carbonic oxide gas, etc.)

4. In many cases, the blood-corpuscles lose totally or partially their capacity of absorbing oxygen: agitated with air, they no longer redden at all, or do so incompletely (dyspnœa and apnœa of the blood-corpuscles). This change of the blood-corpuscles was demonstrated by Dujardin and Didiot in some cases of serious disease (in certain severe cases of typhus and pyæmia, in the last stage of pulmonary tuberculosis).[*] I have, likewise, found it several times completely in the dead subject, and in some severe cases of disease partially at least, in the form of diminished capacity of the blood-corpuscles to redden themselves. The diagnosis is very easy : we require only to agitate with air defibrinated blood, or blood-cakes broken up and mixed with serum. This is best done in a large glass, which contains for one volume of blood ten volumes of air at least. Normal blood becomes very rapidly light-red : after some time it again becomes dark, but reddens again on agitation with air, and very long retains this property. Defibrinated blood of a venesection, kept in an open glass, and agitated with air from time to time, retains generally for weeks this property of reddening by the oxygen of the air, although subsequently the reddening results more slowly and incompletely than at the commencement, when it is fresh. If the blood, while in the living body, loses this property, important effects ensue ; in higher degrees of this change, life can no longer

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* Comptes rendus, Tom. XXIII, p. 227.

exist, and death very rapidly sets in, but even slighter degrees produce very considerable disturbances of the metamorphosis of tissue.   Hence the subject has a great practical importance.   It is a great pity, that we do not yet know the causes, which deprive the blood-corpuscles of the capacity of absorbing oxygen.

§. 19. The *symptoms* of cyanosis are usually complex, the results of proper cyanosis being in most cases combined with those of its causes.   The phenomena of proper cyanosis are in particular reduction of temperature, coldness of the peripheral parts, and other signs of defective metamorphosis of tissue ; depression of the muscular and the nervous system, sopor, in higher degrees complete asphyxia.   With this is ordinarily associated an accumulation of blood in the venous system, in all those cases at least, in which the circulation through the lungs is checked or impeded.   Hence a bluish-red injection of the surface of the body, especially of the face and the lips, a complication which is so frequent, that from it the whole condition has obtained the name cyanosis.

For practical purposes, it is not sufficient to have demonstrated the presence of cyanosis, we must also always endeavour to discover its *cause*.

§. 20. The *therapeutics* of cyanosis must, above all, be directed to the *removal of its cause ;* if this cannot be removed, every treatment is fruitless.

The attempt has been made to supply in such cases more oxygen to the blood, and indeed in various

ways : by the inhalation of pure oxygen gas out of gasometers—this, as a rule, does not succeed according to my experience and that of others (Bouchardat), because breathing out of a gasometer is too inconvenient, especially for patients suffering from higher degrees of dyspnœa ; by surrounding the patients with an artificial atmosphere of oxygen gas—this calls for such costly contrivances, and its use seems so doubtful, that the proposal has yet found no admittance into practice (except some earlier experiments of H. Davy's) ; by the administration of chlorine, as chlorine-water, which, as it combines with hydrogen to form hydrochloric acid, sets free oxygen that, in its nascent state, is said to unite with the blood-corpuscles more readily than the oxygen of the air. This method is quite useless, nay often mischievous, as the small quantity of chlorine, which may be used internally without scruple, is not enough to produce a striking effect; but larger quantities of chlorine have other injurious collateral effects.

Hence in all cases of cyanosis, in which the cause cannot be removed, only a *symptomatic* treatment is left. We seek to mitigate the most prominent phenomena of the disease by appropriate remedies —the peripheral coldness by warm clothes and frictions; the frequently existing palpitation of the heart by acids, with or without digitalis ; the venous hyperæmia, if it attains a high degree, by the cupping-boot, and general or local abstraction of blood.

DISSOLUTION OF THE BLOOD-CORPUSCLES.

§. 21. Each blood-corpuscle has, no doubt, only a limited period of existence ; it perishes after some time, is dissolved, and vanishes, though we know not where and how this takes place.* In the normal condition, the new formation of blood-corpuscles balances their dissolution, so that the percentage of corpuscles in the blood, and their total number remain un-changed within certain limits. In disease, however, this relation may be disturbed, and more blood-corpuscles may perish than form anew, so as to cause oligocythæmia, which has been already described. But sometimes a large number of blood-corpuscles is rapidly destroyed, as if by a stroke, which soon produces not only oligocythæmia and its consequences, but also another very striking phenomenon, which has often roused the attention of pathologists ; viz., the blood becomes surcharged with the constituents of its dissolved corpuscles, especially with their colouring-matter. Its serum appears of a bloody colour, and the dissolved hæmatin passes off, likewise, with the exudations and secretions. This causes sanguineous, or if the colouring-matter of the blood is changed, brownish exudations of the colour

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* Sometimes the liver, and at other times the spleen, has been re-presented as the organ in which the blood corpuscles are said to be destroyed. As regards the following remarks, the reply to this disputed question is quite immaterial. There are many reasons for believing, that this disintegration of the blood-corpuscles takes place in all parts of the vascular system.

of dung-water : by the imbibition of the dissolved hæmatin, the skin and the mucous membranes acquire a yellowish tint, which is often erroneously regarded as icterous : by the dissolved hæmatin in a more or less altered state, the various secretions become of a blood-red, brownish, or even blackish colour.

This dissolution of large masses of blood-corpuscles may be local, and limited to a portion of the vascular system, in which the circulation ceases : this form constitutes an essential element of local *mortification*, of gangrene, and, indeed, sometimes its commencement, sometimes its termination. In other cases, a great part of the freely circulating blood-corpuscles begins to decompose, and is rapidly dissolved, causing *general blood-dissolution, general gangrene*— a form which, if not quickly checked, very soon leads to death. In another class of cases, by an agent capable of decomposing the blood-corpuscles, a portion of the latter is dissolved, which comes into direct contact with the decomposing agent ; but the efficiency of the cause being thereby exhausted, the remaining blood-corpuscles continue uninjured, and no general blood-dissolution ensues. The intensity of the results,—diminution of the blood-corpuscles, colouring of the blood-serum, and of different secretions by the colouring-matter of the blood,—is proportionate to the number of blood-corpuscles destroyed.

Attempts have been made to explain the dissolution of large masses of blood-corpuscles in various ways : by *blood-dissolution*, but this is only a naming of the fact, no explanation of the cause ; by *putrefaction*,

(blood-putrefaction), but this is a very indefinite designation, which has the disadvantage of preventing further investigations by the show of an explanation, and of leading to erroneous or unsatisfactory therapeutical indications. If we reflect, that the blood-corpuscles are instantly dissolved by a great many things, outside the body, by water, lactic acid, acetic acid-carbonate of ammonia, etc., it becomes probable, that this extensive dissolution of the blood-corpuscles within the living organism, is also dependent, in different cases, upon different causes; and we ought not, therefore, to content ourselves, in any individual case, with the insignificant assumption of a blood-putrefaction, of a typhous, scorbutic blood-dissolution, etc., but to investigate its proper efficient cause. As such probable or possible causes, towards which the aim should be directed during investigations, may be indicated the occurrence of acetic acid, lactic acid, phosphoric acid (?), formic acid (?), carbonate of ammonia, and hydrosulphate of ammonia; and the action of arseniuretted hydrogen gas.*

A successful treatment of this dissolution of the blood-corpuscles is, of course, possible only in those cases, in which the efficient agent is known, and may be controlled. In all other cases, we must restrict ourselves to a symptomatic treatment of the *results;* must promote the elimination of the products of decomposition accumulated in the blood, that they may

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* That in men and in dogs a dissolution of blood-corpuscles may be produced by the inhalation of arseniuretted hydrogen gas, I have shown in the Archiv des Ver. f. gemeinsch Arbeiten, Vol. I, Part II.

not give rise to secondary ill-consequences by undergoing further decomposition ; and must remove the oligocythæmia that is left behind.

As it is important to recognise such dissolution-conditions of the blood, and to discover their causes as early as possible, any colouring of the urine, or of any other secretion by dissolved hæmatin, but especially that of the serum, which separates from the blood of a venesection or of hæmorrhages should be carefully attended to.

B. COLOURLESS CORPUSCLES OF THE BLOOD.

§. 22. Besides the proper red blood-corpuscles, there are found in normal blood, as is well-known, numerous other colourless corpuscles (lymph-corpuscles), whose signification and function, however, are as yet entirely veiled in obscurity. While they are, according to one view, young cells still in a state of formation, from which the coloured blood-corpuscles are developed ; they are, according to others, independent cells, which have nothing to do with the proper specific blood-corpuscles—abortive blood-cells. Their mode of origin, and the seat of their formation are equally unknown. According to some, they originate only in the chyle and the lymph, and are, by the passage of these juices into the blood, mixed with the latter ; according to others, they may arise in the blood itself.

A precise knowledge of their number and weight is also still wanting. It has been sought to determine

these, partly by chemical separation and weighing (H. Nasse), partly by approximate calculations; but both methods have hitherto yielded very unsatisfactory results.*

As we yet know so little about the normal relations of these corpuscles, it is conceivable that their pathological relations are veiled in still greater obscurity. Only *one* abnormal condition of them has hitherto played a part in pathology—their *excessive increase.*

A moderate increase of the colourless corpuscles does not seem to be rare. It has been observed after losses of blood, in inflammations, in pregnancy, in typhus, in intermittent fever, and in many other diseases, especially of a chronic type. But, with the incompleteness of the methods, hitherto in use, of determining the quantity of the colourless corpuscles, absolute as well as relative, *i. e.*, in relation with the red corpuscles, all these statements are very untrustworthy, and still need confirmation by precise modes of investigation. We know just as little that is certain regarding the *results* of such an increase of the colourless corpuscles. The following view has been assumed in preference : the lymph-corpuscles, if present in an increased number, are said to stagnate in the capillaries, and thus to produce inflammation mechanically. This view is quite unfounded, for even in

* *H. Welcker* is engaged, at this moment, in the development of a method of determining by calculation the amount of colourless corpuscles in the blood in an exact manner.

cases, in which an extreme increase of these corpus-
cles takes place, in leukæmia, such a stagnation can-
not be observed.

The lymph-corpuscles, when present in an increas-
ed amount in the blood, are said to escape from the
vessels, to pass into the exudations, and to form pus-
corpuscles in them (Addison, Zimmermann). This
view too, for a fundamental refutation of which this
is not the place, seems very improbable.

As yet, the only morbid condition of the lymph-
corpuscles, which has a practical importance, is

LEUKÆMIA (LEUCOCYTHÆMIA),

i. e., An extreme increase of the colourless corpus-
cles, with a simultaneous diminution of the red.

§. 23. To Virchow, who was led to it by the in-
vestigation of the blood in the dead subject, is due
the merit of having first stirred up this subject, and
of having further elucidated it for a series of years
with great perseverance. Besides him, Bennet of
Edinburgh has obtained special credit for throwing
light upon this disease. I have, for the first time in
Germany, diagnosticated leukæmia in the living sub-
ject (1849). Since then, numerous other cases have
been observed and described in Germany, England,
and America.

The most important memoirs which describe the
present state of the doctrine of this disease, are those
by Virchow in his Archiv, Vol. V, pp. 43—128 ; by

Bennett in the Edinburgh Monthly Journal, 1851, January, April, August, October, and his mono-graph on Leucocythæmia.

§. 24. The *diagnosis* of leukæmia consists in the demonstration of an extreme increase of the colour-less corpuscles in the blood. This may be done in various ways :—

1. By the microscopic investigation of the blood, for which a single drop is enough. The colourless corpuscles appear abnormally increased in it, they form $\frac{1}{6}$th, $\frac{1}{4}$th, even $\frac{1}{2}$, and more, the number of the red. Still more accurate determinations of their number by exact methods would be desirable.

2. If a large quantity of blood, obtained by vene-sections or the cupping-glasses, is freed from fibrin by beating, and placed in a high, narrow little glass, so that the corpuscles sink to the bottom, the upper part of the mass looks whitish coloured, like milk. The milky character does not vanish on agitation with ether, and is not produced by fat-globules sus-pended in the blood-serum, but by the prodigious number of the colourless blood-corpuscles. This distin-guishes it from lipæmia, to be subsequently consider-ed (compare §. 44).

3. The cake of leukæmic blood shews on its sur-face greyish-white granulations, which, being observ-ed under the microscope, consist almost entirely of colourless corpuscles (distinction from the ordinary buffy coat)—the separated serum is clear, not turbid (distinction from lipæmia.)

4. In the dead subject, there are found, in the heart and the great veins, large, soft, semi-fluid, greyish-yellow, dregs-like coagula, which, on microscopic investigation, consist almost entirely of colourless corpuscles.

§. 25. Leukæmia does not readily occur by itself alone, so far as the not very numerous observations, hitherto made, admit of such a conclusion. Usually, other pathological phenomena are combined with the augmentation of the colourless corpuscles.

In the same degree, in which the colourless corpuscles increase in the blood, do the red diminish, and, consequently, the amount of hæmatin and of iron in the blood, so that relative, probably also generally absolute oligocythæmia, occurs. In the remaining blood-constituents, especially in the amount of water, albumen, and salts in the serum, no essential abnormal deviations have hitherto been found ; yet upon this subject more precise investigations are the more to be wished• for in future, as, in a case of leukæmia, Scherer found in the blood hypoxanthin, gelatine, formic acid, and acetic acid,* constituents which are foreign to normal blood.

An enlargement of the *spleen*, which is often enormous, constitutes the most frequent complication of leukæmia (Virchow's lienal form of leukæmia). It is so frequent, that the presence of enlargement of the

* Verhandlungen d. physik-med. Gessellsch. zu Würzburg. Vol. II, p. 29.

spleen, otherwise inexplicable, leads to the supposition that leukæmia exists, and thus prompts to an investigation of the blood. In nineteen cases of leukæmia, this enlargement of the spleen was sixteen times present. To what a prodigious degree this enlargement of the spleen may extend in leukæmia, becomes evident from the fact, that the weight of this organ was, in three cases, estimated at more than seven pounds.

Besides the spleen, the *liver* is also frequently enlarged, but rarely to so striking a degree as the spleen. In nineteen cases, the liver was thirteen times enlarged, or otherwise morbidly altered.

The *lymphatic glands* are also frequently enlarged, and pathologically changed. (In nineteen cases of leukæmia eleven times). This alteration in the lymphatic glands is found as a main complication, (lymphatic form of leukæmia), generally with enlargement of the spleen, but more rarely without it.

Besides the spleen and the lymphatic glands, other blood-glands also occasionally appear degenerated (thyroid gland, supra-renal capsules).

Leukæmia occurs in *both sexes,* and at *every age.* Of 25 cases, 16 were male, 9 female.

One case was observed under 10 years of age ; two cases between 10 and 20 years ; three cases between 20 and 30 years ; seven cases between 30 and 40 years ; four cases between 40 and 50 years ; three cases between 50 and 60 years ; three cases between 60 and 70 years.

§. 26. The *effects* of leukæmia itself upon the system, from the novelty of the subject, and the small number of well-observed cases, cannot be strictly separated from the phenomena which are produced by its complications. The following description comprises all the symptoms which are usually present and characterise this disease.

One of the most frequent symptoms, and, in the majority of instances, the most prominent of all, is a tumefaction of the abdomen, dependent upon an enlargement of the spleen and the liver, which may be easily detected by percussion. Ascites and anasarca of the lower half of the body are sometimes associated with it. There are often transitory pains in the abdomen, dependent upon transitory disturbances in the circulation, hyperæmia, and inflammation of limited parts of the serous covering of the spleen and the liver caused by•pressure of these enlarged organs against neighbouring parts.

Intestinal disorders are often present ; such as vomiting, constipation, and more frequently diarrhœa.

Respiration is usually affected, and a high degree of dyspnœa is observed, greater than is explicable by the elevation of the diaphragm alone in consequence of the enlarged spleen and liver.

Hæmorrhage often occurs, especially epistaxis.

Of abnormal conditions in the function of the metamorphosis of tissue, a persistent increased secretion

of uric acid through the urine has been especially remarked.

When the disease is long continued, a high degree of emaciation ordinarily sets in.

Leukæmia almost always runs a chronic course, which is often very lingering. Frequently, no remarkable disturbances in the general state of health are present for a long time, especially no fever, and the nature of the disease is generally mistaken for a long while. Afterwards fever with a hectic character is generally developed, and, in fatal cases, brings about the fatal issue.

The cases, hitherto known, have been fatal, or the disease still continues ; sure instances of cure are unknown.

§. 27. The causes of leukæmia are entirely unknown, and it is impossible, at present, to give a *theory* of this disease, which is even partially satisfactory. What produces the increase of the colourless, and the simultaneous diminution of the red corpuscles ? Are they, as seems probable from many reasons, the *effect* of the enlargement of the spleen and the lymph-glands, or are they the *cause* of these enlargments, or do both the conditions depend upon a common cause ? Further, what *effect* has the increase of the colourless corpuscles upon the organism ? The reply to all these, and to other questions, is, at present, impossible, and must be reserved for future investigations.

Until that time a rational *treatment* of leukæmia is impossible. The most various remedies

have been tried, without checking the increased formation of colourless-corpuscles. Hence there is left nothing but a symptomatic treatment of the most prominent symptoms, according to general therapeutical rules. We should guard ourselves against a too debilitating and active treatment !

II. CHANGES IN THE CONSTITUENTS OF THE LIQUOR SANGUINIS.

I. FIBRIN.

§. 28. According to the view of most authors, the fibrin forms a constituent of the liquor sanguinis, and is dissolved in it. Others believe, that it is not dissolved in it, but is contained in a gelatinous condition, or in the form of fine granules and molecules.

The *use* of the fibrin is not yet sufficiently evident. As the coagulation of the blood depends upon it, it certainly, plays an important part in the suppression of hæmorrhages, inasmuch as by it alone is the formation of a thrombus possible. The other functions, attributed to it, are still to a certain extent doubtful, and disputed. According to some, the fibrin is that constituent of the blood from which are derived all new formations of tissues arising from protein-substances ; according to others, all nutrition and new formation depend upon the albumen of the blood, and the fibrin is considered as an excrementitious substance destined to be eliminated.

A positive decision of this question seems, at this moment, impossible, although many important reasons appear to me to speak for the former view.

Some (Magendie) also assign to the fibrin the function of facilitating the circulation of the blood in the capillaries by its presence, so that, by a considerable diminution of it, stagnation of the blood is said to occur in them. This view is also still hypothetical.

We know just as little that is certain regarding its *origin*. While some assume, that it originates externally to the blood, as a product of the metamorphosis of tissue, especially of the substance of muscles; according to others, it is formed in the blood, and either, as some suppose, from the albumen of the blood-serum, or, according to the conjecture of others, from the globulin of the corpuscles. But none of these various views can, at present, be so established, in contra-distinction to the others, as to be deemed the most probable, and to allow conclusions respecting the pathological relations to be based upon it.

Another unfortunate circumstance is associated with these chasms in our knowledge of the fibrin. The true chemical composition of this substance, and its chemical distinctions from allied protein-compounds (albumen, casein) are, in spite of many meritorious works upon the subject, and notwithstanding the opposite statements of Mulder, not yet precisely known. To us the fibrin is only that particular protein-substance of the blood, and of other fluids of

the body, which possesses the property of coagulating of itself. Where this property is lost, there exists no more fibrin for us; where it seems considerably modified, so that spontaneous coagulation results very tardily, or only under special conditions, we find opinions divided as to whether the substance in question is to be enumerated as fibrin, or not.

It appears necessary to draw attention here to these great chasms still existing in our knowledge of the fibrin, because its abnormal conditions play an important part in many recent systems of pathological Hæmatology.* The pathological abnormal conditions of the fibrin, which have been observed, are 1, increase; 2, diminution; and 3, alteration of it.

INCREASE OF FIBRIN (HYPERINOSIS.†)

§. 29. According to Becquerel and Rodier, normal blood contains, on an average, 2.2 parts of dried fibrin in 1,000 parts. This holds good both in males and females. In males, the minimum of the normal condition is estimated at 1.5, the maximum at 3.5; in females, the normal minimum at 1.8, the maximum at 2.5: hence variations within these limits are still to be considered as normal

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* The most important works upon the morbid alterations of the fibrin are *Andral's* patholog. Hæmatologie; *Becquerel* and *Rodier* in various memoirs; *Popp's* Untersuchungen; *Richardson*, the fibrinous element of the blood in relation to disease.—Medical Times, 1851, November.

† According to Simon, composed of ὑπερ and ἱς (ινος) = muscular fibre.

If we assume the total amount of blood in the body at 12,000 grammes, the whole quantity of dried fibrin in the blood will, according to the above mean number, be 26.4 grammes.

The quantitative determination of the fibrin takes place in the following modes : either the fibrin is separated by beating the blood, by agitating it with grains of shot, little pieces of stone, etc., and the coagulum, thus obtained, washed carefully with water, or all the blood-corpuscles are removed from the blood-cake by expression, kneading, and washing with water. In both cases, the coagulum is dried, and, if the determination is to be very accurate, freed from fat by ether, and weighed. Both methods yield pretty much the same results, so that the numbers obtained by them may, without hesitation, be compared with one another ; but both methods are laborious, and take up much time, and can, therefore, but rarely find application in medical practice.

Another mode of determination, practised by Polli, is less tedious, and may be rapidly performed. He determines the specific gravity of the fresh blood, and of blood from which the fibrin has been removed by beating, etc., and estimates the amount of fibrin from the difference between the two. The results of this method seem, however, very untrustworthy.

§. 30. An increase of the percentage of fibrin in the blood above the normal maximum (relative hyperinosis) is often observed. Physiologically, it is

found almost always in pregnancy, especially in the latter months of it ; pathologically, in all inflammations, in acute articular rheumatism, and in the earlier stages of tuberculosis, cancer, and Bright's disease. In some of these diseases, especially in intense cases of pneumonia, pleurisy, and articular rheumatism, the increase may be considerable, and rise to 10, 12, or even 13 in 1,000 parts. In all cases of such a considerable increase, the hyperinosis cannot be merely relative, but must also, of course, be absolute, *i. e.*, the total amount of fibrin, contained in the blood, must far exceed the above-mentioned mean quantity of 26 grammes.

Since Andral and Gavarret's investigations, medical men have attached a great importance to this increase of fibrin in disease, and have not only declared it to be a characteristic sign of the inflammatory diathesis, but have also, more or less consciously, regarded it as the special agent in inflammation, and attempted to derive from it many, nay all the phenomena, which occur in the course of the latter. Nevertheless, all these views regarding the part which the augmentation of fibrin is said to play in inflammations, and the supposed consequences of hyperinosis deduced from them, are entirely hypothetical, and cannot stand a critical examination.

The view that the increase of fibrin, as such, may call forth fever, is unfounded. We find an increase of fibrin without any fever in the pregnant state, and, on the other hand, violent fever (typhus, &c.,) without augmentation, nay with diminution of the

amount of fibrin in the blood. Of the influence of the increase of fibrin upon the metamorphosis of tissue, we know nothing certain.

It is possible, that a relative increase of fibrin in the blood might call forth a tendency to the separation of this excess by processes of exudation. This view, which, if confirmed, would be of great practical importance, is, however, for the present altogether hypothetical.

Only *one* result of the increase of fibrin can, as yet, be indicated with greater certainty than those already mentioned : viz, the greater the amount of fibrin in the blood, the richer in fibrin will, *cæteris paribus*, be the fluids that are secreted from the blood, so that those events, which depend upon the presence of coagulable fibrin in exudations, will occur in them in a proportionately higher degree.

The proximate *causes* of the increase of fibrin are still very obscure, as well as its results. A few remote causes only have been demonstrated with more or less probability. Thus, in many cases, an increase of fibrin has been observed to arise from increased action of oxygen upon the organism and acceleration of the respiratory process (Simon, Mulder, Gairdner).* In other cases, increased formation of fibrin seems to be produced by local irritants, blistering-plasters, wounds, etc. According to the investigations

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* C. Schmidt found no augmentation of the fibrin, on artificially increasing the action of oxygen upon the blood by the injection of osmic acid. Charakteristik der epidemischen Cholera, p. 4, Note.

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of Cahen fils,* the amount of fibrin in the blood rises and falls in an inverse ratio with the alkalinity of the blood-serum, and hyperinosis is said to depend upon the circumstance, that the blood contains less carbonate of soda than in the normal condition (compare § 43).

Remedies, which counteract hyperinosis, are most of the neutral salts, especially nitrate of potash and soda, alkaline carbonates, alkaline salts of vegetable acids, tartar-emetic, sulphate of soda, and sulphate of magnesia. The fact that, on being mixed with the fresh blood, they prevent or greatly retard its coagulation, as well as the direct experiments of Popp and others, though the latter are, indeed, based upon no very great number of observations, speaks for the efficiency of these remedies. Calomel, to which the same property is attributed, does not seem to possess it. In several cases of stomatitis mercurialis, Andral found the amount of fibrin in the blood augmented. Abstractions of blood, local as well as general, have decidedly no diminishing influence upon hyperinosis.

In order to demonstrate the increase of fibrin in the blood, the above-mentioned quantitative determination of the fibrin is necessary. The presence of a buffy coat upon the blood-cake is no positive indication of it, as the buffy coat is sometimes produced, though rarely, even without hyperinosis, by the slow coagulation of the blood, and the rapid subsidence of the corpuscles.

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* Récherches e xperimentales sur l'alcalinité du serum du sang humain. Bullet. de l'Acad. de Med. 1850, Tom. XV.

DIMINUTION OF FIBRIN (HYPINOSIS).

§. 31. In disease, the quantity of fibrin occasionally falls below the physiological minimum (1.5—2.0 in 1000 parts). Becquerel and Rodier* distinguish this alteration in the blood by the name "scorbutic state." As this designation has been derived from the probably incorrect hypothesis, that the pathognomonic peculiarity of scorbutus consists in a diminution of fibrin, the name *hypinosis*, introduced by Simon a long time ago for the latter, seems, certainly, more appropriate.

Hypinosis is met with frequently as an accompaniment of the "states of dissolution" of the blood, with more or less marked dissolution of the blood-corpuscles, in cases of putrefaction of the blood, in purpura hæmorrhagica,† in many cases of scorbutus and typhus, in secondary syphilis, and in old cerebral affections and paraplegias;—occasionally as an accidental complication of other morbid processes, anæmia, Bright's disease, dropsies, cardiac diseases, protracted suppurations, etc.

It is demonstrated with certainty only by a quantitative determination of the fibrin in the blood, according to the above-mentioned methods. It may, with more or less probability, be expected to be found, when the blood drawn by venesection, etc., forms,

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* Gazette Médic., 1852, No. 31.

† In a case of purpura hæmorrhagica febrilis, which terminated fatally, the blood, which was investigated by Becquerel, contained no trace of fibrin. Hérard, l'union, 1853, 1.

on coagulation, a soft diffluent jelly separating little
or no serum, instead of a firm cake.

As *results* of hypinosis, are indicated : a tendency
to spontaneous hæmorrhages, and to the formation
of extravasations of blood, ecchymoses, and other
sanguineous secretions ; great prostration and debi-
lity of the nervous and the muscular system ; and
difficult suppression of hæmorrhages, produced by
external causes or otherwise.

The last of these statements is in so far justifiable
physiologically, as the coagulability of the blood is di-
minished, and consequently the formation of a throm-
bus retarded, by the diminution of the fibrin of the
blood. But as the suppression of bleeding may be
caused by other circumstances besides the formation of
a thrombus, (contraction of the vessels, etc.), hypinosis
is, certainly, not the sole cause of the tendency to
hæmorrhages, as indeed is shown by experience. The
other results of hypinosis mentioned above are altoge-
ther hypothetical—their occurrence depends very pro-
bably not upon the diminution of fibrin, but upon
simultaneous changes in the other blood-constituents
(dissolution of the blood-corpuscles, etc.).

The *causes* of hypinosis, so far as we yet know
them, may be distinguished into proximate and
remote. As remote causes, are mentioned : defec-
tive, especially bad, putrid food ; insufficient action
of oxygen, with impeded or diminished activity of
respiration ; and excessive metamorphosis of the mus-
cular tissue (in hunted animals). Scarcely any one
of them has, however, been positively established by a

sufficient number of undoubted observations. The proximate causes are probably such chemical agents, as destroy the coagulability of the fibrin, for instance, increase of carbonate and basic phosphate of soda in the blood, and accumulation of nitrates or sulphates, or the occurrence of carbonate of ammonia in it. But still more precise investigations of them are to be wished-for. Besides, it is not to be overlooked, that many of these causes, the carbonate of ammonia, for instance, act also destructively upon the blood-corpuscles, and thus convert the alteration in the blood into a complex one.

The treatment of hypinosis must, of course, have in view, above all, the controlling of its cause : in the case of an increase of soda, and the presence of ammonia, the mineral acids should be given ; in excessive accumulation of the nitrates and the sulphates, copious water-drinking seems to act best, by increasing diuresis, and by diluting the blood. In addition to these, fresh air, and good diet, are advantageous. The most important results of the disease require a corresponding symptomatic treatment.

CHANGES IN THE FIBRIN.

§. 32. Certain alterations in the fibrin have a much greater importance in practice than its increase and diminution, although they have not hitherto met with the consideration due to them. They refer to the degree of coagulability of this substance.

1. The most important of these changes is its *increased coagulability* (inopexia).* The fibrin, which, in the normal condition, does not coagulate within the organism, but does so only some time after its removal from the body, loses this property, and coagulates while within the body. Such coagula of blood are found almost in every corpse, in the heart and the large vessels. But it is almost always only a portion of the blood of the dead subject whose fibrin coagulates, while the greater part remains fluid, and coagulates, quite in the usual manner, some time after its removal from the body. In the living subject, such a coagulation of the fibrin takes place more rarely, but frequently enough to render its occurrence a matter of great importance. It is probable, that in the living as well as in the dead body, it is not the whole amount of fibrin, but only a portion of it, which exhibits this tendency to coagulate. The results of inopexia may be mentioned here but briefly, as they will meet with a minute consideration in many parts of the Hand-Book of Special Pathology and Therapeutics. They are: formation of coagula of blood within the vascular system, sometimes only local, sometimes more general—in the heart, the veins (phlebitis adhæsiva, etc.), the arteries, or the capillaries ; and coagulation of fibrin in extravasations of

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*ἴς, ἴνος and πηξις (Coagulation.) I have coined this new word, because it appears to me more convenient to denote this so frequent and so important a condition by a short term, than to use every time the long expression, "disposition of the fibrin to coagulate in the living body," instead of it.

blood, and in exudations. The latter, especially, is an important phenomenon of inflammation, and inopexia has generally, I am convinced, a greater importance in inflammation than hyperinosis, which it often accompanies.

The *causes* of inopexia are almost entirely unknown. We do not even know the reason why normal blood coagulates after its removal from the body ! They are perhaps partly identical with, or similar to, those which produce hyperinosis ; such as diminution of the soda, or the sulphates in the blood. According to the experiments of Millington and Lee,* the tendency to the coagulation of the blood is said to be increased by an admixture of pus with the latter. And according to Lee, the injection of pus into the veins of animals (asses) produces a rapid coagulation of the blood, which comes in contact with the pus.

Other foreign bodies, when in contact with the blood, seem also to promote the coagulation of its fibrin.

Retarded circulation and stagnation of the blood, acts, further, as a promoting cause of inopexia (compare Sect. II, §. 54 et seq., of the Hand-Book of Special Pathology and Therapeutics).

The *diagnosis* of inopexia rests upon the demonstration of the coagulation of fibrin in the body, within the vascular system, and in extravasations and exudations. A rational *treatment* of it is not yet in existence. We possess no sure means of destroying

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* Medical Times, April, 1852, p. 401.

the excessive coagulability of the fibrin. Hence there is left for the present only a general treatment of the conditions, in which it occurs, of inflammation, etc., and a symptomatic treatment of its results. Of remedies, the nitrate, carbonate, and other salts of potash or soda, are the most promising.

§. 33. 2. In some cases, the blood, drawn by venesection, coagulates very slowly, after several days (Polli's bradyfibrine). The effects and causes of this rarely occurring abnormal condition of the fibrin, are unknown.

Something similar is occasionally observed in exudations—these coagulate very late, only some days after their removal from the body. This may be owing to the fibrin having lost its property of spontaneous coagulation and regaining it slowly, or to the presence of a substance, which is not fibrin, but which becomes, by unknown causes, gradually transformed into it, and coagulable (Virchow's fibrinogen). Something similar may be artificially produced by mixing sulphate of soda, etc., with normal blood ; it thereby loses its coagulability. By diluting the mixture with water, this property is restored. Indications of great practical importance will probably result from a continued study of these relations. Should any one succeed in discovering sure and harmless methods of depriving the fibrin of exudations and extravasations of its tendency to coagulation, it would be a great accession to Therapeutics, inasmuch as time would be thereby gained for

bringing about a complete resorption of these morbid effusions, without permanent pathological new formations being developed from them.

Some other modifications of fibrin, which have been described (Mulder's oxyprotein—Polli's parafibrin), are either still doubtful, or appear, as yet, to be unimportant in Pathology.

2. ALBUMEN.

§. 34. As regards quantity, albumen forms, next to water, the main constituent of the liquor sanguinis. According to Becquerel and Rodier, in healthy individuals, male as well as female, there are contained, on an average, 80 parts of dry albumen in 1000 parts of blood-serum. Lerch[*] assumes a somewhat smaller mean number (75. 1), Popp a somewhat higher one (88.).

The quantitative determination of the albumen in the *blood-serum* can be made with great accuracy. A certain weighed, or measured quantity of serum is mixed with so much acetic acid, as to become almost neutral, and the mixture poured into boiling water. The albumen is completely coagulated by boiling for a short time, washed with water, dried, and weighed. This method is, however, too tedious and minute for practical purposes. Hence an attempt has been made to calculate the amount of albumen in the serum from the specific gravity of the latter : but the

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[*] Einige chemische Untersuchungen über das Blutserum. Dissertat. Würzb., 1845.

result of this calculation is not very accurate.* According to Becquerel, the amount of albumen in the serum may be determined more accurately, and, at the same time, very rapidly, by the polarising apparatus of Soleil ; but the high price of such an apparatus must render its employment for medical purposes very limited.

The reply to the question, how much albumen the *whole* blood contains, is very uncertain. According to the very hypothetical, indeed, probably incorrect mode of calculation, introduced into science by Prevost and Dumas, which forms the basis of most analyses of the blood (of those of Andral and Gavarret, Becquerel and Rodier, Popp, etc.), 1000 parts of normal blood would, on an average, contain about 70 parts of albumen. From this would follow a proportion of 840 grammes of dry albumen for 12,000 grammes of blood, *i. e.*, for the entire blood-mass of the body. If it is, on the other hand, assumed with C. Schmidt, that the serum forms but about half the weight of the blood, the whole amount of albumen in the blood would be only 480 to 500 grammes, and therefore considerably less.

Opinions are also divided upon the *use* of the albumen of the blood in the organism. According to some, it serves for nutrition, and new formation, while others attribute this function to the fibrin.

* This is evident from the investigations of Becquerel and Rodier, as well as from those of Lerch. The former consider 1027. 5 as the mean, 1026. 5 as the minimum, 1028. 5 as the maximum, sp. gr. of normal serum.

More certain, and, at the same time, more impor-
tant in Pathology, is another function of the albumen,
hitherto not duly appreciated ; viz., the part it plays
in the endosmotic actions of the blood within the
body. By the blood, especially the liquor san-
guinis, forming a watery solution of great concentra-
tion, it acquires the property of absorbing thinner
fluids, according to the laws of endosmosis, as well
from the stomach and the intestinal canal, as from
the parenchyma of various organs. But the blood-
plasma owes this capacity chiefly to the amount of
albumen contained in it, which forms $\frac{8}{9}$ths of its solid
constituents.

The abnormal conditions of the albumen, hi-
therto known, are its increase, diminution, and al-
teration.

INCREASE OF ALBUMEN (HYPERALBUMINOSIS).

§. 35. Regarding the increase of albumen in the
blood, little certain is known. Hence the following
sketch must almost entirely be confined to hypo-
theses, for whose confirmation or refutation future
investigations are required, and which, as they lead
to important practical conclusions, I feel disposed
to recommend to a careful examination. The aug-
mentation of the albumen may be *relative*, *i. e.*, 1,000
parts of serum may contain more than the normal
amount (above 80 parts) of albumen ; or *absolute*,
i. e., the whole amount of albumen contained in the
blood may be increased.

A relative increase of the albumen, which may be positively demonstrated according to the above methods, occurs (except some cases to be particularly considered hereafter (cholera, etc.)) rarely, and seldom exceeds a moderate degree (Lerch found 90.3 as the maximum.) The reason of this probably is, that serum, when very rich in albumen, attracts water with energy, on account of its great density, and retains what is attracted. Relative hyperalbuminosis, which alone we are in a condition to demonstrate with certainty, would thereby vanish, and an absolute one appear instead of it. But the result of this event would be an increase of the blood-mass, a plethora. Indeed, we find in plethora the amount of albumen in the serum high, often above the normal standard, as is evident from the investigations of Becquerel and Rodier,* who expressly remark, that in plethora they have found the serum generally rich in albumen, and of high sp. gr. (1028.4 on an average). Popp,† likewise, states that the highest sp. gr. of the blood-serum, which he has found, occurred in a case of plethora.

Hence the conclusion seems justifiable, that every considerable increase of the albumen in the blood produces an augmentation of the mass of the blood, plethora, chiefly of the serum (serous plethora).

Further, there are many reasons for believing, that hyperalbuminosis calls forth a tendency in the

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* Neue Untersuchungen, etc. Translated into German by Eisenmann, p. 32.

† P. 63

organism to the separation of the excess of albumen
from the blood, by albuminuria, and by other secre-
tions which contain albumen, especially upon the
external integument (eczema and forms of impetigo),
or from mucous membranes (blenorrhœa).

The increase of the albumen in the blood, and the
just-described results thereof, seem to play a part in
many forms of morbid processes, which are usually
comprehended under the name scrofulosis.

The *causes* of hyperalbuminosis seem pretty much
the same as those, which have been enumerated as the
causes of an increased formation of the blood-corpus-
cles (§. 11); such as an augmented supply of albumen
to the blood, exceeding the consumption of that sub-
stance. To this head belongs very copious nutriment,
especially such as is rich in protein, with slight mus-
cular exertion, and weak respiration, etc. Youth,
especially childhood, and a peculiar disposition of the
organism, seem to constitute promoting causes. In
practice, two important classes of hyperalbuminosis
must be distingushed :

1. Where the blood, besides being rich in albumen,
is also rich in corpuscles ; the hyperalbuminosis being
combined with polycythæmia. This form leads to
true plethora, and is frequently found in powerful
well-nourished individuals, and also in many diseases,
especially in gout, and at the commencement of
hæmorrhoids. It arises from abundant nutrition with
proper development of the corpuscles.

2. Where the increase of albumen is not accom-
panied by increase of the blood-corpuscles, but rather

by a diminution of them. Here food being abundant, the blood-serum is abundantly formed, but the production of the corpuscles from it is defective. This form leads to serous plethora, and is a frequent accompaniment of many morbid conditions.

Hyperalbuminosis almost always occurs together with a diminution of the soluble salts of the serum, especially of common salt, a fact of great practical signification, to which we shall often revert.

A rational *treatment* of the augmentation of the albumen must make the removal of the causes its special task ; must, therefore, be similar to that of polycythæmia; such as moderate amount of nutriment containing little protein ;* increase of muscular movement, and of the metamorphosis of tissue, and fatiguing exercise in the open air, etc. : in addition to these, of course, a symptomatic treatment of the results.

There is perhaps still another remedy, which will reduce the amount of albumen in the blood, or prevent its increase, when diatetic measures are not sufficient. According to the observations of C. Schmidt,† whenever the blood is poor in albumen, a quantity of salt is absorbed, as a compensation for the diminution of the latter (a diffusion-equivalent, *i. e.*, for 7 to 8 parts of albumen 1 part of salt). As salt and albumen may, therefore, to a certain degree,

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* Becquerel and Rodier, indeed, mention that the quantity of albumen in the blood does not diminish by scanty nourishment; but their method of investigation states only the *relative*, and not the *absolute* amount of albumen in the blood.

† Charakteristik der epidemischen cholera, in many passages.

replace each other by endosmosis in the liquor san-
guinis, it would perhaps be possible to diminish the
amount of albumen in the blood, or, at least, to
counteract its augmentation, by an increased supply
of salt. At all events, this effect is attained, though
very transitorily, when neutral salts are employed
as purgatives. A part of the excess of albumen is
removed from the blood by their aperient action,
and, as a portion of salt is, at the same time, absorb-
ed into the blood, it is replaced by salt. This ex-
plains the well-known favorable effect of oft-repeated
saline purgatives, especially of the regular use of
mineral waters, in all the different conditions, which
depend upon hyperalbuminosis. Drastic purgatives
(aloes, jalap, gamboge, senna without salt, etc.),
as every practitioner knows, act less favorably in
such cases. In the stools thereby called forth, albu-
men is, indeed, likewise found, but also a large
quantity of salts (6 to 8 times the amount of albu-
men). The blood therefore becomes by them not
only poor in albumen, but still more so in salts ; and
as it partially repairs its loss out of the fluid con-
tained in the parenchyma of organs, it probably be-
comes much richer in albumen than before.

A regularly continued use of saline remedies,
especially of common salt, seems to counteract hyper-
albuminosis, and to be able to cure it in a lasting
manner.*

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* The following facts may for the present serve as proofs of this
practically so important a statement, my numerous investigations re-
garding this subject being not yet concluded: after two months'

A merely *relative* hyperalbuminosis originates in all processes, which rapidly remove from the blood a quantity of water and salts, but little or no albumen (cholera, profuse diarrhœas, drastic purgatives, etc.).* But, if other morbid disturbances be not superadded, it is quickly removed by the absorption of water from other parts of the body, or by the drink that is taken ; and requires no therapeutical interference.

use of common salt, Plouviez found the amount of common salt in his own blood increased, and that of albumen, on the contrary, diminished (*Heller's* Archiv, 1847, p. 464). In several persons, who had employed the water-cure at Nauheim, I likewise found the amount of common salt in the blood augmented, and that of albumen diminished.

* C. Schmidt has demonstrated this very positively, as regards cholera, in the work several times mentioned, as is shown by the following table, whose column 1 gives the quantity of salts, left after boiling, and column 2, the amount of the remaining constituents, not volatile at 248° Fahr. (albumen, with extractive matters and fats), which are contained in 1,000 parts of serum.

1,000 parts of blood-serum contained :

A. in the normal condition,

	1.	2.
In the male,	8. 57	82. 59
In the female,	8. 42	74. 43

B. in cases of cholera,

	1.	2.
No. 1. female,	6. 71	92. 99
„ 2. male,	7. 58	112. 54
„ 3. female,	7. 60	104. 20
„ 5. female,	7. 66	96. 40
„ 6. male,	7. 55	153. 21
„ 7. male,	10. 13	128. 18

DIMINUTION OF ALBUMEN IN THE LIQUOR SANGUINIS
HYPALBUMINOSIS—(HYDRÆMIA).

§. 36. The diminution of the albumen in the liquor sanguinis has hitherto been more studied, and is, therefore, better known to us, than its increase. It may also be either *relative* or *absolute*; the former is, like the corresponding increase, easily demonstrable, and may, therefore, be diagnosticated positively ; the latter cannot be determined with the same certainty, and is hence more hypothetical.

Relative hypalbuminosis may attain a tolerably high degree ; the amount of albumen in 1,000 parts of serum may fall from its normal height (80) to 70, 60, 50, or less (the minimum observed by Becquerel and Rodier being 37.2).

With the increase of relative hypalbuminosis, the sp. gr. of the blood-serum sinks from its normal height (1027.5) to 1020, even to 1016.

Further, the amount of water in the serum always increases with the diminution of the albumen. While in the normal condition, in 1000 parts of serum, it is, according to Becquerel and Rodier, estimated at 910 as the mean, at 904 as the minimum, and at 914 as the maximum, in hypalbuminosis, it rises to 920, 930, 940, and even to 953. Hence this alteration of the blood has also been understood as an augmentation of its water, and, therefore, called *hydræmia*. This expression has, however, given rise to much misunderstanding, and since in such complicated morbid relations, as they are present in the

disorders of the blood, an inaccurate application of terms may cause much harm, the following critical remarks will not, I hope, seem unnecessary, or pedantic.

The amount of water in the blood increases, as has just been shown, with the diminution of the albumen in the blood-serum. But, as the blood-corpuscles contain more solid parts than the serum, it, of course, increases still more, in case of the relative diminution of the blood-corpuscles. Hence many have designated relative oligocythæmia hydræmia or hydrohæmia, and not incorrectly, according to the literal sense of the word.* The name hydræmia, if it is to express an augmentation of the percentage of water in the blood, involves, therefore, two essentially different alterations, and if, as is frequently done, sometimes the one, and sometimes the other, condition is called hydræmia, this leads, not only to theoretical errors, but also to bad practical results. Hence the term hydræmia must either be allowed to drop entirely, except as an expression for a definite condition indicated by chemical analysis, but of no use in Practical Medicine, on account of its plurality of meaning ; or it must be used as identical with hypalbuminosis, for an augmentation of the water in the liquor sanguinis, instead of the more accurate but unusual expression hydroplasmia. As the word hydræmia has been adopted in science, and is difficult to root out, and is, moreover, shorter and more convenient than

* Thus, *Champouillon*, Gaz. des Hôpit. 1852, No. 134.

hypalbuminosis, the latter course is perhaps more advisable, and I shall always employ the expression in that sense.

The diminution of the albumen in the liquor sanguinis is not always counterbalanced exclusively by water. The albumen is very often, in protracted cases of hypalbuminosis probably always, replaced by salts, especially by common salt. But this replacement does not take place by 1 part of salt replacing 1 part of the albumen of the scrum, but there enter, for 100 parts of albumen, 6 parts of soda, or 13 parts of phosphate of soda, or 31 parts of chloride of sodium, and so forth, according to the proportion, calculated by C. Schmidt,* of his so-called *"hydratationsverdichtung."* On an average, about 8-10 parts of albumen are replaced by 1 part of the salts of the blood mixed in the ordinary ratio.

We may suppose an *absolute* hypalbuminosis to exist, when the relative has attained a high degree, and, in addition, the signs of a simultaneous increase of the mass of the blood (plethora) are wanting ; or when a relative hyperalbuminosis does not co-exist with the phenomena of a diminution of the blood-mass (oligæmia). Yet in this change of the blood, in contradistinction to many others, the results of the relative are more considerable than those of the absolute condition. The *results* of hypalbuminosis, so far as they may be yet reviewed, are :

1. The capacity of the blood to imbibe and to resorb into it thinner fluids through the vascular walls, according to the laws of endosmosis, is diminished. This effect extends to the substances introduced into the stomach and the intestinal canal from without, *i. e.*, to food and drinks ; the absorption of the products formed out of them into the blood goes on with greater difficulty, and digestion is impaired. It extends further to the various parenchyma-fluids, whose constituents pass into the blood less readily in hypalbuminosis, than in the normal condition. But probably the passage of the constituents of the liquor sanguinis into the parenchyma of organs, through the vascular walls, also occurs more easily in hydræmia, than in a state of health. Hence, in all cases of hypalbuminosis, we observe a tendency to *dropsy (hydrops serosus)*, which is more or less pronounced according to its degree.

2. In hypalbuminosis, nutrition and new formation are almost always deranged; but this derangement does not seem to be a direct result of the diminution of the albumen. With the large quantity of albumen which the blood contains, a diminution of it, even to the extent of 100 grammes or more, can scarcely produce any effect, as sufficient formative material is evidently still present in the remaining albumen. This disorder of nutrition probably depends mainly upon the circumstance, that the parenchyma-fluids are, in such dropsical conditions, surcharged with the products of the metamorphosis of tissue, with extractive matters, etc., which exercise a disturbing influence upon nutrition.

3. Probably a higher degree of hypalbuminosis also deranges the formation of the red blood-corpuscles, and thereby leads to oligocythæmia.

§. 37. The *cause* of hypalbuminosis is always this, that the secretion of albumen from the blood, somehow or other, exceeds the supply introduced into it. But this may happen in very different ways :

1. By very copious or long-continued morbid secretion of unaltered, or modified albumen (mucus, milk, etc.) from the blood—by albuminuria, albuminous diarrhœa, long continued suppuration, and large exudations ; by losses of blood ; by mucous discharges ; and by a too profuse secretion of milk, absolutely, or relatively with reference to nutrition and the strength of the body, as long-continued suckling, suckling several children, and galactorrhœa. Hypalbuminosis arises the more readily from any of these causes, the less the loss of albumen is repaired by appropriate nutriment. Where the latter is the case, it does not take place at all. In a well-fed individual, with a good appetite and a powerful digestion, I found very considerable albuminuria of one year's duration, without hypalbuminosis having occurred.

2. By diminished supply of albumen to the blood. As the albumen of the blood is constantly consumed for the purposes of nutrition, and perhaps too of the metamorphosis of tissue, its amount must diminish, if no sufficient restitution of it takes place. But this deficient supply of albumen may be caused by aliment,

insufficient in quantity, and especially poor in protein-substances ; or by the existence of one or other of the manifold conditions of disease, which either disorder the appetite, and thereby prevent the absorption of food, or, somehow or other, impede digestion, and assimilation, *i. e.*, the passage of the protein, taken as food, into the blood. As these conditions may be extraordinarily various, and as the mode of operation of each of them is so clear, that nobody can be in doubt as to which belong to this class, a detailed enumeration of them seems here superfluous.

3. While the two classes of causes of hypalbuminosis just mentioned, are quite undoubted, a third is at present still hypothetical. It is possible that, by a morbid increase of the metamorphosis of tissue, a considerable quantity of albumen might become changed and consumed in the blood, without serving nutrition, so that an augmented consumption of albumen might occur in the body, and hydræmia be thereby brought about, even without the secretion of albumen, and without increased nutrition ; yet this mode of diminution of the albumen has not hitherto been proved.

A merely relative hypalbuminosis may perhaps arise temporarily from an increased supply of water to the blood (copious drinking, etc.). It must, however, be transitory, and can never attain a high degree, as is shown by the following considerations.

If we assume that half the blood-mass ($=$ 6000 grammes) consists of serum, it will contain 480

grammes of albumen (80 per thousand). But the mass of the serum might, by copious drinking, rise to 7000 grammes, which would now contain only 480 grammes of albumen—an assumption, which very probably far exceeds the limits of what is physiologically possible. 1000 parts of serum would, in that case, contain 66 parts of albumen.

§. 38. *Occurrence and Complications.* Hypalbuminosis occurs very often, and accompanies the most various kinds of morbid processes. Hence only its most important forms and complications can be touched upon in this place.

Like oligocythæmia, hypalbuminosis appears as a frequent result of all severe morbid processes, chronic as well as acute, if the absorption of nourishment has been disturbed by them for a long time, while the waste of matter has continued. In such cases, it seems frequently complicated with oligocythæmia. Thus, it is often observed in the latter stages of cardiac diseases, pulmonary tuberculosis, and severe chronic disorders of digestion, in protracted intermittent fevers and other malarious affections, in Bright's disease, etc.

Its frequent combination with dropsy is especially important. It may, as is evident from the above, be the primary disease, and produce dropsy as a result. Yet the reverse relation of cause and effect may also take place : dropsy, which has originated in mechanical disturbances of the circulation, or in a direct tendency to exudation (inflammatory dropsy), causes hypalbuminosis secondarily by the direct

secretion of albumen from the blood, and by disordering the appetite and nutrition, etc.

The *diagnosis* of this alteration in the blood is usually purely conjectural. In general, the appearance of œdema and dropsy, without any local or mechanical cause being discoverable, such as closures of veins, inflammation, etc., gives rise to the supposition that hypalbuminosis exists. The demonstration of a diminution of the albumen in the blood by the means mentioned above, will ensure the diagnosis. If this proof by analysis cannot be obtained, the result of the mode of treatment that is applied may, indeed, render the diagnosis more probable, but will never constitute a positive evidence.

§. 39. In the *treatment* of hypalbuminosis, a careful investigation of its causes, and their removal, or, at least, their mitigation, form the main task. The chief indications are therefore the suppression and the controlling of habitual hæmorrhages, suppurations, diarrhœas, and mucous or other exhausting discharges; the removal of the patient from malarious regions; the improvement of nutrition, and the augmentation of the proportion of albumen in the blood by nutritious food, meat-diet, beer, and wine, in combination with general dietetic measures; such as providing for salutary air, and for a salutary abode, careful attention to the state of the skin, promoting the appetite, etc.

These dietetic means are to be supported by appropriate medicines. Among these, preparations of

cinchona take the first rank (decoct. cinchonæ, extract. cinchonæ, or if these cannot be borne, cinchona-coffee,* tinct. cinchonæ simpl. and composita). Next come bitter, bitter-aromatic, and aromatic remedies, and stomachics (wormwood, gentian, quassia, calamus, coffee of acorns,† ginger, etc.)

It must be left to the tact of the physician, or, more correctly speaking, to a careful consideration of all the prescriptions, which General Therapeutics and the Materia Medica suggest, to select from these remedies such as are suited to the peculiarities of the case, and, besides the medicines named, to employ others for the existing complications, preparations of iron, for instance, in the complication with oligocythæmia, and so forth.

The dropsy, which so frequently coexists, demands a special therapeutical consideration. It is, as has already been mentioned, sometimes the result, and sometimes the cause of hydræmia. But it deserves notice in the treatment of hydræmia, not only in the latter, but also in the former case, as a high degree of dropsy always puts obstacles in the way of the cure of hypalbuminosis. In most cases of dropsy, digestion is impaired, all the secretions are suppressed, especially that of the kidneys, and the fluid, moistening the parenchyma of organs, is

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* Some drachms of cinchona-powder are boiled in water, and the latter, instead of simple hot water, is used in the preparation of coffee in the ordinary way.

† Acorns are dried, burnt, and pounded, and then infused or boiled in water. Trans.

surcharged with excrementitious matters, and nutrition is thereby deranged. As dropsy constitutes an obstacle to the cure of hypalbuminosis, so does hydræmia, *vice versâ*, impede the cure of dropsy.

In such cases, a simple dietetic course, the introduction of an abundant supply of albumen by food and tonics, etc., is not sufficient ; it is necessary to interfere more energetically, in order to remove directly the excess of water in the liquor sanguinis, and thereby to cure the relative hypalbuminosis. This is done best by exciting the different secretions. As these are all more watery than the blood-serum, they render the blood poorer in water ; and, further, as they contain either no albumen, or, if any, but a trace of it, and, at all events, for 1 part of albumen more salts than the blood-serum, they likewise render the latter richer in albumen, but poorer in salts. Increase of the renal, the cutaneous, and the intestinal secretion, generally acts equally favorably in this respect, and it depends upon the peculiarity of the case as to which class of remedies (diuretics, purgatives, or diaphoretics, and which among them,) must be employed.

The following considerations may explain the chief principles, according to which the treatment must be adapted to individual cases.

In acute and recent cases, as well as in merely relative hypalbuminosis, strong purgatives, which call forth violent watery evacuations, and diuretics, have the most rapid and surest effect. In cases, where co-existing hyperinosis, or inopexia, or a tendency to

it, renders it desirable, that the liquor sanguinis retain a rich proportion of salts, the saline remedies should be selected for the purpose (acetate, citrate, and other vegetable salts of potash and soda, nitrate and sulphate of potash and soda, sulphate of magnesia, phosphate of soda).

But, where there is no tendency to the increase of fibrin and to coagulation, the non-saline diuretics and purgatives deserve the preference (baccæ juniperi, infus. and decoct. herbæ digitalis, decoct. ononidis spinos., infus. semin. et. herbæ petroselini, ol. terebinthinæ, tinct. cantharidum, and squills; of purgatives, aloes, jalap, senna, gamboge, and colocynth). They separate not only the excess of water, but also that of the salts in the liquor sanguinis, and this latter effe seems to oppose the increase of albumen in the b to a certain degree.

Diaphoretics deserve the preference only where any irritation of the intestines or th kidneys seems dangerous. From among them sometimes the internal sudorifics are selected—warm infusions (infus. sambuci, etc.), extract. sambuci, acetate of ammonia, and Dover's powder; at other times the external; such as warm clothes, vapour-baths, spirituous frictions, hydropathic swathings, and baths of hot ashes.

The more chronic the case, and the more the patient has been reduced, and his nutrition disturbed, the more careful must the treatment be, and with so much the greater precaution must we proceed in the employment of active remedies, when they appear for any reason indicated.

CHANGES OF THE ALBUMEN IN THE BLOOD.

§. 40. It is undoubted that the albumen of the blood may undergo various changes, and thereby differ from its normal constitution. Many such changes have already been demonstrated (by Bouchardat, Liberkühn, Panum, Scherer, and others), and it is probable in a high degree that these play a part in the blood-diseases. But their relations are still so obscure, that they cannot, at present, be attended to in practice ; and the working out of this department must be left to a future period.

§. 41. The case is similar with different other blood-constituents. It is impossible, in the present state of science, to demonstrate positively the influence, which quantitative and qualitative changes in them exercise upon the origin of diseases and of individual morbid phenomena ; but, on the other hand, every one, who has, in a certain measure, followed the more recent advances of Animal Chemistry, and who does not designedly close his eyes against the advantages gained by them, must feel convinced, that such an influence actually exists, and that a continued zealous endeavour to elucidate those relations will and must lead to an essential transformation of the whole system of medicine, hitherto in existence. Until that time shall have arrived, in a work, which is to represent the present state of science and of practice, and, at the same time, to urge on to the perfection of them, the

duty seems to be, neither to ignore entirely those relations, nor to fill up the existing chasms by untenable hypotheses, or, more correctly speaking, by chimeras ; but briefly to draw attention to those points, whose working out will evidently be fruitful of results in Pathology and Therapeutics ; and, likewise, to indicate the course which must chiefly be followed, in order to make further progress.

SALTS OF THE BLOOD.

§. 42. The blood contains various salts (about 10 parts in 1000 parts by weight), which form some of its essential constituents, some (phosphate of potash, iron) being combined chiefly with the corpuscles, others (chloride of sodium, salts of lime, etc.,) chiefly with the serum. The function, which they perform individually in the blood, is still very incompletely known, and we know still less that is certain of their influence in disease. That they do exercise an influence, is, however, unquestionable, and may be proved from many already well-known facts. Since time immemorial, salts have been employed as medicines in many diseases, and they, certainly, act not only as purgatives, diuretics, etc, but also directly upon the blood itself.

It has been already mentioned, that many salts probably exercise an influence upon the amount of fibrin in the blood (sulphates, nitre, alkalies, etc.) ; that others, especially the ferruginous preparations, seem to promote an increased formation of the

blood-corpuscles ; and that common salt may replace the albumen of the blood to a certain degree, and remove an augmentation of it.

As regards all these relations, a sufficient number of positive facts, which can be obtained only by quantitative chemical investigations, is still wanting. The task of the immediate future in this respect should be to multiply these investigations, and to invent for them simple methods, which may be performed even by practical and clinical physicians.

I have already succeeded in developing such a simplified method for the quantitative determination of the common salt (chlorine) in the blood and the blood-serum, which may be performed by any physician, without pre-supposing any special skill or knowledge, and yield a result in a few minutes.*

Similar methods may, certainly, be developed for other salts of the blood by the co-operation of physicians and chemists.

ALKALINITY OF THE BLOOD.

§. 43. The fact that the blood has an *alkaline* reaction, has a high physiological importance, which has been rendered conspicuous in more recent times, especially by Liebig.† Important morbid disturbances in the metamorphosis‧of tissue, etc., are probably produced either by an increase, or by a diminution of the amount of alkali in the blood. Cahen

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* *Vide* Correspond. Blatt d. Ver. f. gemeinsch. Arbeit. No. 4, p. 44.

† Chemische Briefe, 3rd Edition, p. 500, et seq.

has made a series of researches upon this subject,* which were chiefly undertaken to establish the hypothesis, that the amount of fibrin in the blood diminishes on an increase of the quantity of alkali, and *vice versâ.*

According to Cahen, inflammatory blood is said to be less alkaline than normal; on the contrary, the amount of alkali exceeds the healthy standard in typhus, and in the putrid condition. I have also made numerous investigations upon this subject, which have, at least, proved so much, that there occur considerable variations in this respect, possessing a pathological signification, but which have, at the same time, shown that the quantitative determination of the alkalinity of the blood-serum is not so easy, as it appears at first sight, and that a method must first be developed, before such researches can be instituted on a large scale.†

FATS OF THE BLOOD.

§. 44. The blood contains different fats, in the quantitative determination of which various investigators, especially Becquerel and Rodier, have been engaged. These investigations have yielded many interesting pathological results; viz., that the proportion of cholesterin in the blood increases in most acute diseases, especially in inflammation and retarded

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* Rechérches experimentales sur l'alcalinité du serum du sang humain, par *Cahen fils.* Bullet. de l'Acad. de Méd. T. XV. 1850.

† Correspond. Blatt des Ver. f. gemeinsch. Arb No. 6

biliary secretion, as well as from scanty food, and in advanced age ; and that with commencing impoverishment of the blood, the fats containing phosphorus especially increase ; and so forth.

A further prosecution of these researches promises to be important in practice, especially as regards the etiology of gall-stones, and of atheromatous deposits in the arteries—it promises to explain the action of the medicinal application of substances rich in fat, such as cod-liver oil, which has become more frequent in recent times. But it is rendered difficult by the circumstance, that the quantitative determination of the fats in the blood requires not only large quantities of material, but also very laborious chemical operations, which take up much time, so that but few physicians will occupy themselves therewith.

Those cases are more easy to diagnosticate, where fats occur in such large quantities in the blood, that they impart a milky character to it, or, more correctly speaking, to its serum (white blood, or better, for distinguishing it from leukæmia, *milky blood, fatty blood—galactæmia, lipæmia*). This condition of the blood may be recognised by its simple inspection. The microscopic investigation of the blood, or its treatment with ether, ensures the diagnosis, and the distinction of fat from colourless blood-corpuscles, or from molecules of albumen (compare §. 24). As regards the results and the pathological signification of this condition, little certain is known. Slighter degrees of it are altogether physiological, and are met with almost regularly during the period of

digestion after eating substances rich in fat. Higher degrees of it rarely occur. They have especially been observed in drunkards. Compare J. Frank, upon white and fatty blood, and its origin in the abuse of alcoholic drinks. Hannoversche Annalen, 1847, p. 283, et seq.

EXTRACTIVE MATTERS, ETC , IN THE BLOOD.

§. 45. The still incompletely known constituents of the blood, comprised under the name of extractive· substances, may, no doubt, undergo various changes, which play a part in disease. Little is as yet known of them. Gelatine, which, according to Bouchardat, occurs normally in the blood, after it has been taken as food, is occasionally found in an increased amount (Bouchardat, Scherer.) There have, likewise, been found leucin, hypoxanthin, formic acid, butyric acid, valerianic acid, etc. From this nothing can be inferred at the present moment, except the existence in this direction of facts of great importance for science and for practice, still unknown, but which, we hope, will soon be discovered.

SECOND GROUP.

ABNORMAL CONDITIONS OF THE QUANTITY OF THE BLOOD.

FULNESS OF BLOOD (PLETHORA), AND DEFICIENCY OF BLOOD (ANÆMIA, OLIGÆMIA).

§. 46. The first group comprised those abnormal conditions of the blood, in which the proportion of the *individual blood-constituents* was disturbed, or in which their properties differred from the normal standard. In this second group, we shall consider a series of morbid conditions, whose most important characteristic has been often deemed to be a deviation of the whole *amount of the blood* from the normal condition, an increase or diminution of it. It is necessary, in the first instance, to distinguish accurately the *elementary forms* of the morbid processes, which produce these alterations in the blood, so as to obtain sound ideas on the subject, and to examine them critically, before it is possible to demonstrate the part which these changes play in complex diseases.

The introduction of these nosological ideas into medicine belongs to a period at which the blood was considered as a whole, as a fluid possessing certain

properties, without any further regard being paid to its chemical composition. Let us then turn our eyes for a moment from the fact, that the blood is a very complex fluid, whose individual constituents may undergo many alterations in their quantity, as well as in their properties.

From this point of view we may with perfect justice assume, that the quantity of blood in the body may increase or diminish, and that this diminution or increase may lead ˜to morbid disturbances in the organism.

But even in the normal condition, the amount of blood in the body is manifestly not the same in all individuals : it is self-evident that an adult possesses more blood than a new-born child, and so forth. It was, therefore, necessary to find a measure, by which the amount of the blood could be determined. The two following presented themselves as such : the *mass of the body*, and *the greater or less fulness of the blood-vessels*. Both of these have been employed to infer a pathological diminution or increase of the blood-mass, without the pathologists, who employed them, being clearly conscious how far their conclusions rested upon a sure basis, and how far they were founded upon pure conjectures.

Both measures are, in fact, singly, as well as conjointly, very deceitful, and must, therefore, when applied incorrectly, or too boldly, lead to errors.

As regards the first method, the fundamental question still to be solved would be, how much blood the human body contains in the normal condition,

and with a given weight ? In spite of all attempts, we have not yet succeeded in answering this question in a perfectly satisfactory manner, and it is only in accordance with a tolerably probable hypothesis, that we assume, that, in the normal condition, the mass of the blood amounts to about ⅓th the weight of the body, to about 12 kilogrammes (24℔s.), the medium weight of the body of an adult being 67 kilogrammes.

I formerly (Allgemeine patholog. Anatomie, p. 59,) proposed a means of determining the quantity of blood in *dead bodies* by a quantitative chemical determination of the amount of hæmatin. The practical performance of this method has hitherto been thwarted by its great difficulty and minuteness. As we, however, now possess in the blood-colour scale (§. 8. *d.*) a very sure and simple means of determining the amount of hæmatin quantitatively, the carrying out of my proposal has now become comparatively easy, and we may soon hope to obtain in this way precise information whether, and how much, the amount of blood in the body may increase, or diminish in various diseases.*

The case is different in the *living subject*. Here any direct estimate of the blood-mass, by weight or by volume, is impossible, and there is perhaps only one case, in which a pathological change of the proportion of the amount of blood to the weight of the

* Compare *H. Welcker* in Fechner's centralblatt f. Naturwissenschaft, 1853, No. 44.

body can be inferred with certainty : viz., when a considerable quantity of blood is lost rapidly by hæmorrhage, venesection, etc., in which case an absolute, as well as a relative diminution of the blood-mass, in proportion to the weight of the body, must take place. For even should a rapid restitution of the lost blood occur, this cannot happen instantly, but must take place gradually. Cases of this kind, especially the frequent instances of bleeding to death, with its striking results, no doubt, first led to the assumption of a pathological diminution of the blood-mass (anæmia). But by proceeding further, and admitting a diminution of the blood-mass even in cases in which no hæmorrhage had taken place, or in which the loss of blood might have already been again made good ; and by assuming, in contra-distinction to anæmia, the occurrence of a pathological augmentation of the blood-mass, the sure ground of experience was left, and a path was entered upon, which necessarily led to manifold errors.

The second measure, by which it was attempted to demonstrate, and even to determine quantitatively, a pathological increase or diminution of the blood-mass, was the greater or less fulness of the blood-vessels. This method was carefully developed in former times by some physicians, indeed, often over-rated. In our own days, it is far too much neglected by many. As its results are frequently of the greatest importance in medical practice, a minute detail of the various methods that are employed, and an examination of their degree of certainty, do not appear superfluous here.

An increase or diminution of the amount of blood has been inferred :—

1. From the degree of *redness* of the body. It is undoubtedly the blood, which gives a red colour to all the externally visible parts of the body (skin and visible mucous membranes). Hence an increase of the blood-mass has been concluded from an augmentation of the red tint (red or florid complexion) ; and a diminution of it, from a pale faded appearance.

This conclusion is however, often delusive, as is shown by the following considerations : the greater or less redness of the skin and mucous membranes depends upon the degree in which their capillaries are filled with blood, or, more accurately speaking, with red blood-corpuscles. But the greater or less filling of the capillaries with blood is often only local, (local hyperæmia or anæmia) : a plethoric person may acquire a pale complexion by transient influences (fainting, depressing passions) ; and an anæmic individual may assume a florid look from a variety of causes (agitation, fever, and exciting passions.) But the inference drawn from the complexion respecting the quantity of blood, becomes the more sure, the more lasting and constant the character of a certain tint is : a habitual florid tint admits of a conclusion being drawn, with a certain degree of probability, respecting abundance of blood ; a habitual pale waxy tint, respecting deficiency of blood. Yet there are many exceptions to this rule. Some persons have, in consequence of a congenital or acquired

conformation, habitually a florid appearance, without their being, on that account, generally rich in blood : the capillaries of their skin and mucous membranes being numerous and wide. Others, on the contrary, look habitually pale, without their suffering from anæmia ; the capillaries of their skin and mucous membranes being few in number, or small in size.

Another circumstance, which has repeatedly given rise to mistakes, and still frequently leads to them, is, that the blood, as such, is not coloured red, but only its red corpuscles—its colouring-matter. But, in any person, the amount of the blood-corpuscles may be diminished, and that of the liquor sanguinis increased. He may suffer from all the signs of plethora, and yet exhibit a pale appearance, a relation such as not unfrequently occurs, especially in the chlorotic.

Hence abundance or deficiency of blood may be inferred from the complexion, only with more or less probability, never with certainty.

2. *From the state of fulness of the larger vessels and of the heart.* The greater or less fulness of the cutaneous veins, and even the degree of it, may, with some practice, be estimated by the eye with tolerable certainty.

The experienced may, by the sense of touch, determine with tolerable accuracy the degree of fulness of accessible arteries, most exactly at the spots where the pulse is usually felt—at the wrist-joints,

and in the carotids ; with a little more practice, even in the crural arteries, and the abdominal aorta, though less precisely.

The increase of the volume of the heart may be demonstrated, though less accurately, by percussion during its diastole, and from this the amount of blood it receives during the same may be determined indirectly.

From these relations the blood-mass has been estimated. Such a conclusion is surer as regards the arteries than as regards the veins, the great majority of the latter being in the interior of the body, and removed from sight. It is the more certain, the more other circumstances support it, if, for instance, the arteries and the visible veins are simultaneously full or empty, and the complexion (the condition of the cutaneous *capillaries*) agrees therewith ; if, further, the amount of blood in the liver and the spleen, which in many cases may be approximately ascertained by percussion, corresponds to the other results ; and if another set of phenomena (results of anæmia and plethora) occur, which will be further treated of below. Nevertheless, the diagnosis remains often doubtful, and is, in the great majority of cases, only probable, rarely certain. But as a probable diagnosis, in conditions which have so great a practical importance as those in question, is always better than no diagnosis at all, the almost systematic neglect, into which these abnormal conditions of the blood, especially plethora, have fallen in the most recent times, is to be very much regretted.

We have hitherto pre-supposed, that in plethora and anæmia the blood retains its normal composition, without regard to its increase or diminution (*pure plethora ; pure oligæmia* and *anæmia*).

But theory and experience show that this is not always the case. Plethora, as well as anæmia, may be caused, likewise, by the greater increase or diminution of one or more constituents of the blood than of others. By this a complicated condition is produced. The plethora and oligæmia combine themselves with oligocythæmia or polycythæmia, hyperalbuminosis or hypalbuminosis, hydræmia, and so forth. Such complications have, of course, a great influence upon the results of these conditions.

The *results* of plethora and oligæmia may be brought under two categories, both of which are but incompletely known to us. Hence the following sketch is only a hypothetical one :—

1. *Effects upon the vessels.* The vessels form tubes, whose walls are not rigid, but elastic, and may, therefore, adapt themselves to a certain degree to changes in the blood-mass, inasmuch as they dilate, if this increases, and contract, if it diminishes. But this capacity of accommodation may be restricted by counteracting causes. We know two such principal causes. Firstly, morbid alterations, which limit or destroy the *elasticity* of individual sections of the vascular system (atheroma, calcareous deposit, and rigidity in the arteries). Secondly, *increased contraction* (tonicity) of the vascular walls. If a large section of the vascular system is prevented from dilating itself

by such causes, an increase of the blood-mass will produce evil effects. The lateral pressure in the entire vascular system must thereby increase, and a variety of pathological phenomena result from it. As such, may be indicated : ruptures of vessels, since the pressure becomes so strong, that certain weak portions cannot hold out against it ; excitement of the heart ; irritation of individual portions of the vascular system, and, consequently, irregular contraction and irregular circulation of blood in them, and exudations into various parts of the body ; excessively powerful dilatation of the yielding parts of the vascular system, and their distension with blood ; and, as an ulterior effect, relaxation of the heart and vessels.

This condition has been denoted by the name plethora ad vasa, or plethora ad spatium. It may not only arise from an actual increase of the bloodmass, and it *never* originates in it alone, but also, without the blood-mass being augmented, from a powerful contraction of large portions of the vascular system, so that the vessels become too narrow for the existing blood-mass. It has, as may be conceived, a great practical importance, and becomes most dangerous, in the case of rigid arteries, or of an existing proclivity to vascular dilatation, or to rupture of vessels in individual parts of the body, in local inflammation, etc., etc.

These effects upon the vessels are brought out much more strongly in plethora than in anæmia. As the vessels, even when their tonicity has been lost,

considerably narrow themselves by simple elasticity, the vascular system may still contract sufficiently in all cases, even with a considerable diminution of the blood-mass, to adapt itself to the deficiency of blood. Should the power of contraction be insufficient, the want will be supplied by collapse of the veins, and resorption of the fluids of the body, as no vacuum can arise.

2. *Effects upon the metamorphosis of tissue.* These can as yet be but incompletely reviewed, in consequence of the great obscurity, in which most points of the doctrine of the metamorphosis of tissue are concealed at present.

In oligæmia, we must, of course, meet with the whole series of effects, with which we have become acquainted as results of a diminution of the blood-corpuscles, of the albumen, of the fibrin, of the salts, etc., to a greater or less degree, in proportion to the diminution of the blood-mass, or of individual blood-constituents. Further, since oligæmia, as will be seen hereafter, rarely remains pure, but becomes usually converted into hydræmia, etc., its results combine with those of the latter secondarily occurring conditions.

In true plethora, there takes place an increase of the metamorphosis of tissue, of the production of heat, and of nutrition, etc., and in complications, the effects of these complications are, of course, superadded.

The *causes* of these conditions are very complicated, and the *treatment* must, likewise, vary according

to their form. We shall consider both more minutely, when treating of the individual varieties.

After this general consideration, which should serve rather as an index than otherwise, let us turn to a special description of the most important forms of these morbid processes.

FULNESS OF BLOOD, FULL-BLOODEDNESS, REPLETIO, POLYÆMIA, AND GENERAL HYPERÆMIA.

§. 49. After the idea of plethora, as an increase of the blood-mass, had been established for centuries, and many important pathological phenomena explained thereby, some have entirely denied it in more recent times, and have endeavoured to explain in another way the morbid phenomena, which undoubtedly take place in those cases that are distinguished as plethora. Thus, plethora has been identified, sometimes with an augmentation of the fibrin (relative hyperinosis), sometimes with an increase of the red blood-corpuscles (relative polycythæmia). Both views are incorrect ; these conditions may occur as complications of plethora, but do not constitute its essence.

The cases of disease, comprehended under the name plethora, may be arranged in three classes : 1. true plethora ; 2. serous plethora ; and 3 plethora ad vasa. Each of these classes may present numerous modifications and complications, of which, however, only the most important ones can be mentioned here.

1. PLETHORA VERA, TRUE FULNESS OF BLOOD.

(Plethora ad molem of Gaubius, and others.)

§. 50. In this disease, the blood is of normal composition, and generally rich in corpuscles, and in albumen —both the latter frequently approaching the physiological maximum, nay occasionally exceeding it. The mass of the blood is augmented, so far as such a conclusion can be drawn, with probability only, from full arteries (from a full and large pulse), from distended veins, and from a florid, red complexion. Besides, the affected individuals present the phenomena of an increased metamorphosis of tissue, an elevated temperature, or, at least, an increased feeling of warmth.

In most cases, this state involves no special disease, but readily leads to it. The beginning of disorders of health is generally brought about by one or other division of the vascular system falling into a state of irregular activity. The heart's action increases, and some portion of the vascular system contracts (the pulse of the corresponding part becoming tense); and hence arises plethora ad vasa, with its results; such as congestions in various parts of the body, especially in the *locus minoris resistentiæ* in the particular case, rupture of vessels, and hæmorrhage; and local accumulations of blood in the yielding parts of the vascular system, or in those disposed to dilate, (hæmorrhoids, etc.). Such ill effects may be called forth by the most various causes, by any powerful corporeal or mental exertion and excitement, (running,

ascending staircases, etc., anger and other passions) ; by spirituous liquors, stimulating food, and stimulating medicines, etc. : in these cases, they pass off often rapidly and without leaving any trace, but may also produce dangerous consequences (hæmorrhages, apoplexies, etc.). Or they are occasioned by an additional disease, in which case the existing plethora exercises a more or less considerable modifying influence upon the course of that disease. The elements of this influence, which have a special importance in practice, are a greater tendency to hæmorrhages, to relaxations (palsies) of individual sections of the vascular system, and consequently to vascular dilatation and hyperæmia ; a greater proclivity to the exudation of the plasma ; and an increased disposition to general and local elevation of temperature.

By these relations, true plethora becomes an important complication of various diseases : many complicated morbid processes, as hæmorrhoids, gout, etc., originate in it (compare Gout §. 43).

True plethora does not always extend uniformly to all parts of the vascular system : the blood is frequently accumulated in individual portions of it in particular, in the veins (venous plethora), or in individual organs, and groups of organs ; such as in the portal system (plethora abdominalis), etc. There are intermediate cases between true plethora and local hyperæmia, and the results are different according to the peculiarity of the case.

True plethora may occur in very various degrees, from a slight, scarcely perceptible, transitory, and still

physiological increase of the blood-mass, to those intense cases, which are usually designated as the apoplectic conformation, and in which all the visible veins are swollen, the face looks dark-red, and the slightest attempt at stooping, the gentlest pressure of the neckcloth, or the least movement and exertion combined with vascular excitement, as running, ascending staircases, etc., calls forth dangerous symptoms. Yet the intensity of the phenomena is not always proportionate to the degree of the plethora; the greater or less tendency to functional disorders of the vessels has more influence upon it. The phenomena are usually the more violent, the greater the tendency of the vascular system is to contract in some places, causing plethora ad vasa, or to relax in others, whereby local hyperæmias are produced.

§. 51. *Causes.* An increase of the albumen and the corpuscles in the blood always constitutes the *proximate* cause of true plethora, and its *remote* causes are the same as those of polycythæmia and hyperalbuminosis mentioned above.

An excess of albumen and of corpuscles is caused by an excess of the supply of protein to the blood above its consumption; but relative polycythæmia and hyperalbuminosis cannot long exist as such, the concentrated blood attracting more water, and firmly retaining it, whereby its mass is augmented. Hence, we meet with true plethora especially in young persons, who, with strong digestive powers, take much meat and other protein-substances, but little exercise. It occurs after the suppression of habitual

hæmorrhages, of hæmorrhoidal bleedings, etc. It is promoted by a peculiar constitution of the body, by a special disposition to copious blood-formation. Climatic relations, and certain seasons of the year, especially spring, likewise, seem to act favorably.

It arises most readily, when healthy, strong persons suddenly alter their mode of living, by a transition from a slightly nutritious diet and fatiguing exercise, to a very nutritious diet, and a state of slothful rest. In these cases, the above-described events are brought out most strongly, and in the purest form.

If a high degree of plethora lasts for a long time, and becomes habitual, complications occur, of which, from their great multiplicity, only the most important ones can be indicated here.

The excess of blood does not remain uniformly distributed over the body. It accumulates itself in certain parts of the body in particular, and thus there originate, according to the nature of the individual, habitual hyperæmia of the brain, and the thoracic and abdominal organs ; dilatations of veins, hæmorrhoids, etc.

The vascular system, and the rest of the body, become so accustomed to the excess of blood, as to be unable to dispense with it. Any great abstraction of blood, profuse evacuation, or restriction of diet, has, in such individuals, much more intense effects than in others, and readily produces collapse.

The *metamorphosis of tissue* is also, no doubt, altered ; but we as yet know nothing certain regarding it.

Thus, habitual plethora becomes an important source, on the one hand, of hæmorrhoidal disease, on the other, of gout.

§. 52. *Therapeutics.*—The most simple and rapid means of removing true plethora, is a *diminution of the blood-mass*, such as is effected artificially by depletion, and naturally by hæmorrhage. General blood-lettings, venesection and arteriotomy, or local, by leeches, scarifications, and the cupping-glasses, or natural hæmorrhages from the nose, the uterus and vagina, the rectum, etc., act precisely in the same manner in this respect, the intensity of the effect being proportionate to the quantity of blood that is withdrawn. Whether, in a given case, the promotion of a natural hæmorrhage, or an artificial blood-letting, and, in the latter instance, whether a general or a local one, deserves the preference, depends entirely upon the peculiarity of the case, upon the organs in which the blood is especially accumulated, and upon the complications, etc.

The same holds good with regard to the *amount* of blood that is to be abstracted. It must generally be proportionate to the intensity of the phenomena, and to the urgency of the case. In young individuals, and in recent cases, especially in plethora of a rapid growth, we may abstract blood freely ; a loss of 1-2 lbs. of blood, and even more, being usually borne very well by such persons. The case is different with persons in whom the plethora has already become rooted, habitual, and constitutional. These.

especially those among them who are affected with piles and rheumatism, or are advanced in age, often do not bear a large abstraction of blood, but readily sink from it. For them a very small blood-letting, of from 4 to 6, or even of 2 ounces, is sufficient, as we know from experience that a slight diminution of the blood-mass is usually enough to produce the wished-for effect. In such cases it is desirable that the physician himself should undertake, or at least watch the abstraction of blood. He can then, according to the effect that takes place, either rapidly close the opened vein, or allow a large amount of blood to flow out.

But the blood, removed from the body, is restored after a time, sometimes more rapidly, sometimes more slowly, according as the conditions are more or less favourable to its restitution. The repair may be either complete, in which case true plethora reappears, or incomplete, the red corpuscles being renewed more slowly than the albumen, so as to produce serous plethora. (§. 54.) Abstraction of blood is therefore by no means a radical cure for true plethora, but only a palliative remedy. For its radical cure, further treatment is necessary. It must be directed against the *causes* of plethora, and is the same as that of polycythæmia and hyperalbuminosis mentioned before. (§. 13. 35.) Its main indications are to diminish the supply of protein-substances by spare diet, consisting chiefly of vegetables; to increase the metamorphosis of the muscular tissue by strong exercise; and if necessary, to produce artificial

derangement of digestion and assimilation, by saline remedies and preparations of sulphur, by the use of mineral waters, etc.*

Where the good disposition and the external relations of the patient render the execution of the necessary measures possible, especially in recent cases, we may succeed in curing plethora radically ; —where it is otherwise, and in old, inveterate instances, in which the complications described before have already set in, or a strict antiphlogistic treatment seems dangerous, a radical cure is not to be thought of, and the treatment can be only palliative. Its special details must be adapted to each individual case, and depend upon its circumstances. The two following leading principles must chiefly guide us in the treatment :

1. We should fulfil the *indicatio causalis*, as far as the external relations of the patient, his inclination, and other circumstances permit us to do so.

2. We should seek to avoid every thing that might cause a transition of the plethora into actual disease. As this is produced most frequently by excitement of the vascular system and increased contraction of the vessels, causing plethora ad vasa, such persons must avoid all corporeal and mental excitement as far as possible, and abstain

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* It seems very desirable, that numerous and precise further investigations be made for the solution of the important question, how far it is possible to cure, or at least to improve, cases of true plethora by a methodical use of the remedies mentioned in §. 13, note, especially of sulphuretted hydrogen.

from spirituous liquors ; their diet should be bland,
etc.

The *complications* of course demand a special treatment.

Diagnosis and Prognosis.

§. 53. The *diagnosis* rests :—

1. Upon the demonstration of an increase of the
blood-mass by the signs mentioned above ; namely,
fulness of the arteries and veins, in combination with
distension of individual organs with blood, a florid
complexion, and augmented production of heat, etc.
This demonstration can be rarely obtained with certainty, generally only with probability.

2. It must also be proved, that the percentage of
the corpuscles is large, showing the absence of relative
oligocythæmia. This may be done with certainty by
the means previously stated.

The *prognosis* is variable. In simple, uncomplicated
cases, all the evil consequences may be prevented by
blood-letting timely performed ; in complicated ones,
especially in those with rigid arteries, and with a tendency to hæmorrhage or to local hyperæmia, the same
remedy also generally succeeds in averting the impending danger, and even the danger to life.

The possibility of a *radical* cure depends upon whether the *indicatio causalis* can be fulfilled, or not. If
the cause cannot be removed, radical cure is impossible ; and hence complicated cases of this kind often
prove a source of anxiety to the physician.

2. SEROUS PLETHORA.

§. 54. The blood-mass is increased, but this in-
crease depends upon a partial augmentation of the
liquor sanguinis, the corpuscles being not augment-
ed, but relatively diminished. Hence the plethora
appears complicated with relative oligocythæmia.

The *proximate cause* of serous plethora is probably
always an augmentation of the albumen of the liquor
sanguinis, a hyperalbuminosis (§. 35). As the amount
of albumen in the plasma increases, without its excess
being applied to the formation of blood-corpuscles,
or to new formation in general, an excessive increase
of the liquor sanguinis is caused by augmented ab-
sorption of water.

Serous plethora is frequently caused by anæmia ; it
is often met with in chlorotic subjects, and occurs
after considerable, or oft-repeated losses or abstrac-
tions of blood; true plethora is readily transformed
into serous by oft-repeated venesections. In some in-
dividuals a peculiar disposition to it exists, which ap-
pears to be mainly owing to increased supply of pro-
tein to the blood, and insufficient formation of blood-
corpuscles and other tissues from the albumen. The
causes of the latter defect seem to be chiefly im-
perfect action of air, light, and other vital stimuli,
and imperfect metamorphosis of tissue.

The *results* of serous plethora are, as regards the
vascular system, entirely the same as those of plethora
generally. It readily produces an excitement of
the heart's action and other functional disorders of

the vessels, a plethora ad vasa with a tendency to congestion in various parts of the body, a disposition to hæmorrhage, and further, a greater degree of susceptibility to blenorrhœa and leucorrhœa than in true plethora.

The effects of serous plethora upon the metamorphosis of tissue are still little known : at all events it does not produce those results of true plethora, which depend upon polycythæmia.

The *diagnosis* of this condition rests upon the signs of plethora generally, *i. e.,* upon the demonstration of a distention of the veins and arteries, together with the consequences described above. The florid colour is deficient in it : the appearance being either pale, or very variable, paleness alternating with transitory redness—the investigation of the blood shows a relative oligocythæmia.

The *prognosis* is essentially the same as in true plethora, or perhaps somewhat more favorable, as the condition is much more frequently a mere transitory one.

Therapeutics.—In serous plethora, abstractions of blood have a temporary favorable action, as in the true form. But, though they are useful at the moment, they are generally prejudicial in their after-effect, as they increase the already existing oligocythæmia ; moreover, the albumen removed by them is, in most instances, rapidly replaced, and they are, therefore, only a palliative remedy, whose employment must be restricted to the most urgent cases, in which danger actually threatens from the serous plethora ; such

as those complicated with rigid arteries, with cardiac diseases, and with a tendency to apoplexy or to dangerous hæmorrhage. But even in such cases, the abstraction of blood should be as small as possible ; a venesection of from two to four ounces, or even less, being often sufficient.

Where no such danger threatens, or where it has been removed for the moment by an abstraction of blood, we should seek in other ways to obviate the excess of liquor sanguinis, and to restrain its production. Saline aperients (sulphate of soda, sulphate of magnesia, and compound infusion of senna,) are best adapted for these objects, and afterwards the long-continued use of neutral salts in digestive doses, (sulphate of magnesia and soda, phosphate of soda, and common salt, from four to six drachms daily, in several divided doses—small doses of tartar-emetic, or other antimonial preparations—iodide of potassium in doses of from 3 to 4 grains daily), and of mercurials (the various mercurial preparations—calomel, hydrarg. c. creta, iodide of mercury, etc.—yet, on account of their possible collateral ill-effect, only when the neutral salts are not sufficient).

The various saline mineral waters (bitter waters of Saidschütz and Friedrichshall) usually act very favorably, especially when they are employed under medical advice on the spot (as at Kissingen, Franzensbad, Kreuznach, Homburg, Nauheim, Salzhausen, Salzbrunn, etc.), in which case we have, in addition to the effect of the salts, the beneficial influence of regulated diet, of residence in the country, of repose

from fatiguing labour, and of cheerful company, etc.*

Further, the regular employment of fat (cod-liver-oil, or linseed-oil, from one to two ounces, and even more, daily) sometimes acts very favorably, especially if urgent symptoms have been previously removed, and after the preliminary use of purgatives. It appears to act on the one hand, like the neutral salts, by limiting the absorption of albumen into the blood, and on the other hand by augmenting its consumption in consequence of the increased plasticity (deposition of fat) in the body.

In all cases, a symptomatic treatment of the complications must, of course, take place, and we are in particular often obliged to combine ferruginous preparations with the neutral salts, on account of the predominance of oligocythæmia.

3. PLETHORA AD VASA. PLETHORA AD SPATIUM. FALSE PLETHORA.

§. 55. In true, as well as in serous plethora, the blood-mass is actually augmented. But there are also cases in which plethora takes place, i. e., the blood-mass becomes too great for the *vascular system*, without its volume being increased, from the mere contraction of the vessels, by which their calibre becomes too small for the quantity of blood that is present. Hence the same mechanical results ensue, as

* For the theory of their action, *vide* §. 35.

in true plethora. The blood is driven into the less contracted parts of the vascular system, and thus causes local hyperæmia, rupture of vessels, hæmorrhage, and increased secretion, etc.

This condition is not, properly speaking, a disease of the blood, but of the vessels ; yet, I believe, that I should here touch upon it briefly, as it forms so frequent a complication of true plethora.

The *proximate cause* of plethora ad vasa is always an increased contraction of a large portion of the vascular system, especially of the arteries. The *remote causes* may be very various, and among the more frequent ones are febrile affections of the system, violent bodily and mental excitement, cold, spirituous liquors, and stimulating medicines. A peculiar irritability of the vascular system stands high among the *predisposing* causes.

According to the intensity and duration of the cause, and according to the state of the organism in other respects, the results are either slight and transitory, or more serious and persistent, so that the *prognosis* in individual cases is very different. The *diagnosis* rests upon the demonstration of an increased tonicity of the arteries (of a hard, tense pulse), with a simultaneous increase of the heart's action and accumulation of blood in the veins, or in individual parts of the body, and with irregularities in the circulation of the blood, etc.

The *treatment* must always be essentially directed against the cause of the disease. Venesection is the sovereign remedy when true plethora is likewise

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present, or when congestions in important parts of the body, a tendency to apoplexy, or existing diseases of the arteries, etc., involve instant danger. When it does not seem to be necessary, or when the condition persists after its employment, we should adopt remedies which reduce the tone of the vascular system, and relax it. The main remedies are moist heat (tepid baths, in the form of full baths, and hand or foot baths), narcotics (especially digitatis, hydrocyanic acid, bitter-almond water, and cherry-laurel water, opium, morphia), and antiphlogistic neutral salts (nitrate of potash and soda, tartar-emetic), some of which are used alone, others in a state of combination.*

In addition to the above, a symptomatic treatment of the individual results and complications, of local hyperæmia, etc., by their appropriate remedies is useful.

§. 56. Besides true plethora (plethora ad molem) and plethora ad vasa, the old physicians, Gaubius, Boerhaave, and others, for instance, distinguish also a plethora per orgasmum, and a plethora ad vires.

In *plethora ad orgasmum*, the blood is said to *expand* so suddenly by heat, solution, etc., as to augment its volume considerably, and to produce plethora. This assumption of an augmentation of the volume of the blood by *expansion* is not proved at all, and is highly improbable.

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* For instance, infus. herbæ digitalis (e. gr. x—xv.) ℥v, sodæ nitrat. ℨij, syrup. simpl. ℥ss. One table-spoonful every hour. Or antim. potassiotart. gr. iij, solve in aq. desitill. ℥v, adde aq. Laurocerasi ℥ij, syrup. simpl. ℥vj. One table-spoonful every hour.

Plethora ad vires is said to be caused by a diminution of the heart's action, which incapacitates this organ from circulating the blood-mass properly. This state undoubtedly occurs, but it seems inappropriate to reckon it as plethora.

DEFICIENCY OF BLOOD. ANÆMIA. OLIGÆMIA.* (CHLOROSIS).

§. 57. The literature of chlorosis and anæmia is extraordinarily rich.

Hoffmann first gave an accurate description of this disease, in his Dissertatio de genuina chlorosis indole, Genevæ, 1753.

Of more recent writings and memoirs, the following deserve mention :—

Turnbull, in the Lancet, 1846; *T. J. Cazin*, Monographie de la chlorose. Memoire couronné en 1850, par la societé de Med. de Gand. Gand. 1850 ; *Richter*, Blutharmuth and Bleichsucht. Leipz., 1851 ; *Valentiner*, Die Bleichsucht und ihre Heilung. Kiel, 1851 ; *Heusinger*, Die. sog. Geophagie oder Malariachloros., 1852.

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* Anæmia (deficiency of blood) cannot, accurately speaking, occur, as nobody can live without blood, and death must, of course, always set in much earlier than a complete deficiency of blood, anæmia in the literal sense of the word, can be formed. Hence, properly speaking, only the term oligæmia is correct, and the name anæmia incorrect. As, however, this latter word has been adopted, and is generally employed, and as no harm can arise from retaining it, it seems pedantic to pretend to reject it. Here the expressions anæmia and oligæmia will be used as perfectly synonymous.

OLIGÆMIA AS AN ELEMENT OF DISEASE.

§. 58. The names anæmia, oligæmia, and chlorosis are used in very different senses. Some understand by anæmia and oligæmia a diminution of the blood-mass, according to the derivation of the words. Others identify these expressions with oligocythæmia—thus, Andral and, after him, most recent authors. Further, instead of a simple pathological elementary form, complicated morbid conditions have been often distinguished by these names, in which the blood-mass is not only not diminished, but is, on the contrary, augmented, and which therefore properly speaking, belong to plethora.

Hence a strict critical examination is here urgently necessary. We shall begin with the description of the elementary forms, and then pass on to the consideration of the more complicated ones.

I. PURE, TRUE ANÆMIA OR OLIGÆMIA.

§. 59. This is that pathological alteration in the blood, in which its *quantity* is *diminished*, without its composition differing from the normal standard. It is very rare, and, in practice, almost never occurs in a pure form. Its existence can be inferred with certainty only immediately after a copious loss of blood, before the latter has been repaired in any way. But this state very soon passes off, and makes room for one of those mentioned below.

True oligæmia, perhaps, occurs also as an accompaniment of many exhausting morbid processes, of

the wasting diseases, of tuberculosis, atrophy, cancer, etc. ; because in many of these diseases, the blood-mass is evidently diminished, as is indicated by the pale, bloodless appearance, the collapsed veins, and the small pulse, etc. As abstraction of blood can by no means be performed in such cases, it is doubtful whether a change in the composition of the blood does not exist, in addition to the evident diminution of the blood-mass. The few facts we possess seem to speak for this view ; the blood-corpuscles being in such cases almost always found relatively diminished (oligocythæmia).

The *results* of oligæmia may, like those of plethora, be considered from a double point of view : 1, as regards the *vascular system ;* and, 2, as regards the *metamorphosis of tissue.*

The vessels contract in proportion to the diminution of the blood-mass, first by elasticity, then by nervous influence (increased tonicity) ; thus, the *arteries* contract,—in which case the pulse becomes small and tense,—as well as the *capillaries* ; the skin and mucous membranes becoming pale in the latter instance. In higher degrees of anæmia, especially when it is very rapidly produced by profuse hæmorrhage, irregularities in the action of the heart, and disturbances in the circulation occur.

The effects upon the metamorphosis of tissue seem to be caused chiefly by the diminution of the blood-corpuscles. As these carriers of oxygen diminish in number, the metamorphosis of tissue is first of all disturbed in the muscular and the nervous system,

and debility, prostration, and, in higher degrees, a loss of the senses, fainting, and even death ensue.

Disorders of nutrition, and of new formation are produced afterwards and less distinctly, and they almost always occur only when the anæmia has long ceased to be pure, and has already passed into one or other of the resulting conditions.

The *treatment* of oligæmia is different according to the intensity of the malady.

Where an extreme degree of anæmia involves immediate danger to life, our only means of cure is *transfusion.* This remedy has been sometimes employed too rarely or entirely rejected, and sometimes used too frequently, and recommended in conditions involving no immediate danger to life; thus, for instance, as a remedy for improving the blood in dyscracies. It is always a serious or even a dangerous operation, and must, therefore, be reserved for the most urgent cases. But where, in consequence of deficiency of blood, life threatens to be extinguished, we should resort to its use without delay.

To describe the apparatus necessary for its performance, is the business of Operative Surgery. As the introduction of pure blood is uncertain and difficult, on account of its rapid coagulation, and as the chief thing is to introduce blood-corpuscles into the organism, it seems most appropriate to employ *defibrinated* human blood that has been carefully filtered through a clean piece of linen, to obtain it free from all coagula and other corpuscular parts. Further, it appears important to inject only a small quantity of

blood, at most a couple of ounces, at a time. By observing this precaution we shall be most certain to prevent one of the main dangers of the operation, viz., a rapidly occurring excessive expansion of the vascular system, with its bad, sometimes fatal results.

In those cases of anæmia, in which life is not in immediate danger, tranfusion seems unnecessary, and it is sufficient to provide the means of a *gradual restitution* of the blood. For the fulfilment of this task, we must proceed as in the treatment of oligocythæmia and hypalbuminosis by dietetic and pharmaceutical remedies (§. 13 and 39). The special indications must, in each individual case, be adapted to the existing complications, and to other circumstances.

II. COMBINATIONS OF OLIGÆMIA WITH ITS RESULTING CONDITIONS.

§. 60. Every considerable degree of true oligæmia passes, sooner or later, into a more complicated state, as the different constituents of the blood are not restored with equal ease and rapidity. After a loss of blood, the water and the salts are renewed the most quickly, the albumen somewhat later, then the colourless blood-corpuscles, and last of all the red corpuscles. Hence oligæmia is combined sometimes with hydræmia, sometimes with oligocythæmia, etc. After great losses of blood, all these alterations occasionally appear one after the other, and in addition serous plethora. But even when the anæmia is produced by other causes besides loss of blood, it is often combined,

from the very beginning or after a longer or shorter duration, with one or other of the conditions mentioned above. In practice, it is a matter of the greatest importance not to confound these conditions one with another, as is usually done, but to distinguish, and to understand them separately, because the successful treatment of individual cases depends upon it. The main forms are as follows :

1. ANÆMIA WITH HYDRÆMIA.

§. 61. The blood-mass is diminished, and moreover the liquor sanguinis is watery, poor in albumen, and contains an excess of salts. Besides, relative oligocythæmia almost always co-exists.

This form occurs as a transitory condition, during the first few days after very copious losses of blood, because the diminution of the blood-mass is then pretty rapidly made good by water and salts, either totally or partially. This condition is gradually removed, the loss of albumen being first repaired, and then that of the corpuscles from the albumen.

But it is met with also as a more lasting, and even as a permanent condition, after oft-repeated losses of blood, or in consequence of exhausting diseases, which are accompanied by considerable derangement of nutrition and sanguification ; thus, for instance, in the latter stages of Bright's disease, tuberculosis, cancer, profuse suppuration, etc.

The results are the same as those of hydræmia ; viz., a tendency to dropsy or flux, and disordered

nutrition and new formation. More or less distinct signs of oligæmia are also present; such as a small pulse, and a pale countenance. The *diagnosis* is obtained from the demonstration of these results, in combination with an investigation of the blood.

The *treatment* is sometimes so simple, that it may be left to nature, at other times very tedious and uncertain, requiring time and patience.

The former is the case when the condition occurs in its acute form, from copious loss of blood ; the appetite and digestion being good. Under these circumstances, it is, in most cases, removed with rapidity, simply by abundant food, but is often transformed into serous plethora.

The cure is difficult when the causes are not removable, or when digestion is so much impaired, as to prevent a rapid renovation of the lost blood-constituents.

The chief indications of treatment are as follows :—

a. To control the causes that are still in operation ; such as continued hæmorrhages, suppurations, and other losses of the fluids of the body.

b. To provide appropriate food, especially such as is rich in protein, meat and other kinds of animal food, for instance ; giving at the same time cinchona and its preparations as a pharmaceutical remedy. If digestion is low, one of the main indications must be to promote it by means of bitter medicines, etc.

c. When it is impossible to cure the condition rapidly, care should be taken to avoid all noxious agents as far as possible, to husband the

strength, and to observe a tranquil, recumbent posture.

2. OLIGÆMIA WITH OLIGOCYTHÆMIA.

§. 62. Almost all cases of oligæmia are complicated with relative oligocythæmia from the very beginning or at a later stage, either because after loss of blood the liquor sanguinis is restored more rapidly and abundantly than the corpuscles, or because when there is a diminished tendency to sanguification, the formation of the corpuscles is more affected than that of the plasma. This complication is therefore uncommonly frequent.

The diagnosis of this condition depends upon the demonstration of oligæmia with co-existing relative oligocythæmia, which however can rarely be done with certainty. Indeed, a *positive* demonstration is at present possible in the dead subject only ; but there are many cases, in which the observant physician can form a diagnosis during life, with such a high degree of probability as to be perfectly satisfactory. This is the case in many phthisical patients in the last stage of the disease, and in cases of exhaustion by lingering or very severe diseases, where a high degree of paleness of the skin and mucous membranes, with a weak small pulse, collapse of the veins, and a small volume of the heart, the spleen, and the liver, leave no doubt on the existence of oligæmia, and the direct investigation of the blood shows oligocythæmia.

The results, and the treatment correspond entirely with those of oligocythæmia.

§. 63. In the morbid conditions referred to anæmia, or which commence with it, *plethora serosa* is very often developed, *i. e.*, the oligocythæmia persists from defective development of the corpuscles, while the formation of the albumen increases so much that the volume of the blood exceeds its normal standard. Beau and others[*] have drawn attention to this circumstance which may, from its frequent occurrence, be easily confirmed by all careful observers. Logically considered, this condition does not, indeed, belong to the complications of anæmia; because it forms the very counterpart of that disease, and thus excludes it. Since it is, however, classed with anæmia in all manuals, compendia, and other writings, and since this has created much confusion in theory and in practice, we may with justice enumerate it here among the complications. Its symptoms, results, and causes, are the same as those mentioned under the head of serous plethora, ; and the principles laid down there (§ 54) likewise apply to its treatment.

§. 64. Like serous plethora, *plethora ad vasa* is not unfrequently caused by anæmia. It is produced chiefly by stimuli which act upon the vascular system, by corporeal and mental excitement, heat, heating food and drinks, and stimulating medicines, as well as by intercurrent febrile diseases, occurring in

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[*] Comptes Rendus, T. xxi. p. 53. For more works, *vide Henle's* rationeller Pathologie. Bd. ii. p. 287.

anæmic patients ; and is, according to circumstances, sometimes transitory, sometimes more persistent.

Anæmia from *condensation* of the blood, which has been assumed by some authors, and in which from a powerful cause, such as frost, fear, terror, various poisons, etc., the blood-mass is said to contract, and its volume to diminish in consequence,[*] seems imaginary ; local anæmia, such as is produced by vascular contraction, having probably been mistaken for it.

§. 65. We should distinguish from the complications of anæmia hitherto considered, which are developed as conditions resulting from it, those that are superadded, as independent diseases, to an already existing anæmia. They may be very various. It is a matter of great practical importance to draw attention to the fact, that every acute disease, which occurs in an anæmic individual, assumes a peculiar character ; a very high degree of debility and prostration arises, the convalescence is protracted, and all severe intercurrent diseases, gastric fevers, for instance, acquire a characteristic, lingering course. Such febrile affections in anæmic subjects are often distinguished by the name "mucous fever or febris mucosa," and it would be desirable to restrict this ancient appellation to the cases named above, and not to extend it to typhoid fevers, as is often done in more recent times.

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[*] *K. G. Neumann*, Algemeine Pathologie, Berlin, 1829, p. 65.

§. 66. From the uncertainty of most signs which serve to distinguish anæmia, and from the great practical importance of this disease, attempts have often been made, in more recent days, to discover further diagnostic characters of it. Various *murmurs* have presented themselves as such, which are audible in the vascular system of anæmic patients, by means of auscultation.

The seat, the causes, and the signification of these murmurs have often been disputed. A detailed criticism of all the views that have been expressed upon this subject, seems the less called for here, because they are treated of in other parts of the Hand-Book of Special Pathology and Therapeutics. I shall, therefore, confine myself to a short, rather dogmatical sketch of them, based upon very numerous observations and investigations of my own.

Three essentially different kinds of anæmic murmurs must be distinguished : 1. cardiac murmurs ; 2. arterial murmurs ; and 3. venous murmurs.

1. *Cardiac Murmurs.*

§. 67. In anæmia and its various complications, murmurs are frequently audible in the heart ; usually a bellows-murmur, which is sometimes intense, and sometimes faint, generally accompanies the first ventricular sound, and is most distinctly heard at the apex of the organ.

The causes of these murmurs, and their mode of origin, are not yet quite evident. The following is the most probable account of them :—

The cardiac murmurs are produced by abnormal tension of the auriculo-ventricular valves, especially of the bicuspid, and by abnormal oscillations dependent upon the tension. This abnormal tension is, however, caused by an abnormal action of the muscular structure of the heart (in respondence to its nerves), especially of those parts of it which stretch the valves. They are decidedly found in many cases, in which no organic changes in the valves, or in the lining membrane of the heart, (endocarditis, etc.), can be supposed to exist.

The following is what is taught by experience regarding the relation of these cardiac murmurs to anæmia :—

These cardiac murmurs are inaudible in many cases, in which other signs indicate the existence of anæmia with great probability, or even with certainty. They are, therefore, no constant accompaniment of anæmia. We, however, hear them too often in anæmic subjects, to regard their presence as merely accidental, and must therefore conclude that they stand in some close connection with anæmia. These murmurs occur most frequently in true anæmia (actual diminution of the blood-mass), especially if cardiac excitement is associated with it ; but they are perceived just as well, if plethora serosa or ad vasa is developed from anæmia. Simultaneously with them, we frequently hear arterial,

and even venous murmurs. I have several times observed that whenever, in anæmic patients, violent palpitations of the heart, and serious disturbances in the circulation produced by them, required small local or general abstraction of blood, after the latter the cardiac murmurs vanished together with the palpitations—a proof that these murmurs do not depend upon oligæmia, as such ; the latter disease evidently contributing so far to the production of these murmurs, as to cause abnormal conditions of the motion of the heart, or to increase the disposition to them.

The presence of these cardiac murmurs may be employed as an auxiliary sign, together with others, in the diagnosis of anæmia. We cannot, however, conclude from their absence that no anæmia exists, as they are not heard in all anæmic persons. Further, they are not always a sign of anæmia, because they also occur in many organic diseases of the heart, (valvular diseases, endocarditis, etc.), without anæmia. This fact is so well known, that many infer the existence of endocarditis from the mere presence of these murmurs, and accordingly perform large venesections, by which the existing anæmia is, of course, increased.

2. *Arterial Murmurs.*

§. 68. In anæmia, murmurs are sometimes, though seldom, heard in the arteries. They consist of an intermittent blowing, sometimes soft, sometimes sharp, which is perceived synchronously with the beat of the

pulse. The pulse has at the same time a peculiar thrilling character, so that the experienced can infer the existence of an arterial murmur from the nature of the pulse. These murmurs are usually heard in all the large arteries, in the brachial, subclavian, femoral, and carotid, and in the abdominal aorta, when a stethoscope is somewhat firmly placed exactly upon the spot where the pulsation of the artery is felt. Blowing cardiac murmurs frequently co-exist. By the intermittence of the blowing, these arterial murmurs may be distinguished very easily and accurately from venous murmurs, which generally accompany them.

These arterial murmurs are evidently dependent upon augmented, peculiarly sonorous oscillations of the arterial coats ; and the conditions of their production seem to be : 1, increased tension of the arterial parietes (manifesting itself by a tense, membranous pulse) ; and, 2, a powerful and rapid impulse of the heart.

But arterial murmurs are found not only in anæmia, but also in other diseases, which present no further sign of anæmia. I have perceived them during the paroxysms of intermittent fever, (they were absent during the intermissions), in typhus, and in cases of catarrhal fever. I have met with them most frequently after losses of blood, and more rarely in chlorosis. They are much more rare than venous murmurs.

Hence their diagnostic signification is, like that of the cardiac murmurs, but a conditional one.

As they are not heard in all anæmic individuals, we cannot conclude from their absence that no anæmia is present. But, on the other hand, their presence admits only of a probable, but of no positive conclusion regarding anæmia. Anæmia certainly seems to be the cause which most frequently calls forth the conditions necessary for their production, such as an increase of the arterial tension, and of the cardiac impulse ; but it is not the *only* source of them.

3. *Venous Murmurs.*

§. 69. These are *continuous,* humming, buzzing, and occasionally musical, singing murmurs, which may be very easily distinguished from the blowing, *intermittent* arterial murmurs. They are most frequently heard on the *right* side of the neck, at the inferior attachment of the sternocleidomastoid muscle (at the junction of the vena jugularis interna and externa). More rarely, we hear them at the corresponding point on the left side of the neck, and still more rarely in other veins (v. cruralis, etc.) They seem to be produced by abnormal oscillations of the *venous valves ;* and when they are strong, they may not only be *heard,* but also *felt* as a gentle thrill by placing the finger upon the part.

These venous murmurs are very frequently met with in anæmic individuals, much more so than the cardiac and the arterial murmurs, which generally accompany them. They are seldom absent in well-

marked anæmia, and therefore must not be neglected as an indication of the occurrence of that disease. They are however found, though more rarely, even when no anæmia seems to be present, and when the chemical investigation of the blood proves the absence of oligocythæmia (Gorup). I have met with them during the paroxysms of intermittent fever, in typhus, in nervous diseases, etc., and even in healthy individuals, without being able to detect the slightest sign of the co-existence of anæmia.

§. 70. From all that has been stated it is evident that the presence of vascular murmurs may aid the diagnosis of anæmia, which is most frequently their remote cause. But from their absence we cannot conclude with certainty that no anæmia exists, nor can we, on the contrary, with our present knowledge infer anæmia positively from their presence, and far less any of its particular forms.

According to the preceding sketch, which is based upon very numerous observations of my own, the controversy that has been carried on for a long time, whether these murmurs are produced in the arteries or in the veins, seems quite unprofitable. They may be produced in both, and the kind of murmur which exists in any individual case, may very easily be determined by the characters mentioned above.

Of the very numerous works upon this subject, I shall only mention here Hammernjik, physiologisch-patholog. Untersuchungen. Prague, 1847, p.

269 et seq. ; V. Gorup-Besanez, in the Archiv. f. physiolog. Heilkunde, Parts VI, VII, p. 532, et seq.

OLIGÆMIA AS AN INDEPENDENT DISEASE.

§. 71. In Special Pathology, instead of regarding oligæmia as an element of disease, compound morbid forms are usually denoted by that name, which are supposed to have anæmia for their basis and starting point. Following this view, we shall in the succeeding sketch consider the diseases commonly referred to this class. They are best divided into two groups ; viz., into *anæmia proper* and *chlorosis*.

1. ANÆMIA PROPER—SYMPTOMATIC ANÆMIA.

Under this head are usually placed those cases in which one of the various forms of anæmia, with its train of secondary phenomena, is produced by a more or less known cause. As, in a practical point of view, the removal of the cause constitutes the main problem in all these instances, it seems most appropriate to group the forms belonging to this class, according to their *causes*. These are chiefly the following :—

1. ANÆMIA AFTER LOSS OF BLOOD.

§. 72. It breaks up into two groups, whose distinction has a practical importance, though they often pass into one another.

A. Acute anæmia occurs suddenly after copious loss of blood, whether from profuse hæmorrhage, or immoderate venesection. At first, it is always true simple oligæmia. Its results and symptoms are paleness of the skin and mucous membranes ; small contracted pulse ; excitement of the heart's action; cardiac, arterial, and venous murmurs ; great muscular debility and prostration ; and disturbances in the functions of the nervous centres, and of the organs of sense. These symptoms may lead to fainting, or even to death itself (in fatal hæmorrhages). In slight cases, and under favorable circumstances, the lost blood may soon be restored, and a rapid convalescence may set in. More frequently, the disease is somewhat protracted, while the lost blood-constituents are being renewed. It then very rapidly ceases to be simple oligæmia, and becomes complicated with hydræmia and oligocythæmia, and is often transformed transitorily into plethora ad vasa, or more rarely into serous plethora.

B. Chronic anæmia is produced usually by oft-repeated small losses of blood. It is almost always a complicated disease from the very beginning.

Anæmia with Hydræmia arises, when the loss of blood is repaired chiefly by the absorption of water and salts into the blood, so as to produce an excess of those constituents. Its symptoms are those of oligocythæmia and hydræmia combined; viz., paleness, muscular debility, and a tendency to œdema and dropsy.

Anæmia with Oligocythæmia. This is produced when the loss of blood is chiefly repaired by the

formation of blood-serum, while the corpuscles are sparingly developed, their number being below the normal standard. Its effects are the same as those of oligocythæmia ; viz., paleness, muscular weakness, and nervous irritability.

Serous plethora. If after loss of blood the formation of albumen and blood-serum goes on, while that of the corpuscles does not keep pace with it, the deficiency of blood is converted into a redundancy of it. Its symptoms are large full pulse ; great irritability of the heart and vessels ; tendency to congestion in various parts of the body ; vascular murmurs ; proclivity to blennorrhœa ; and pallid countenance, etc.

Plethora ad vasa is very often superadded as an intercurrent complication, sometimes temporarily, at other times more persistently. Its symptoms are, as described before, a small, tense pulse ; excitement of the heart's action ; and congestion in various parts of the body, etc.

2. ANÆMIA AFTER LOSS OF THE FLUIDS OF THE BODY.

§. 73. Anæmia may be caused not only by loss of blood, but also by a very copious, or long continued loss of other fluids of the body, especially of such as contain protein-substances. Thus from excessive secretion of milk, protracted suckling, suppuration, profuse blennorrhœa, leucorrhœa, diarrhœa, etc.

In these cases, the oligæmia is generally complicated with relative oligocythæmia, or with hydræmia.

Serous plethora seldom arises, except during the period of convalescence. Plethora ad vasa is, however, more frequently superadded.

3. ANÆMIA FROM INSUFFICIENT AND IMPROPER NUTRI-
MENT, OR FROM DISTURBANCES IN THE ABSORPTION,
ASSIMILATION, AND SANGUIFICATION OF FOOD.

§. 74. The blood constantly furnishes materials which serve for the nutrition of the body, the metamorphosis of tissue, and the formation of excretions, etc. To repair this loss, food proper in quantity and in quality must be constantly supplied to the blood. Hence anæmia is produced by a defect in the quantity or quality of the food, by fasting, starvation, and by aliment containing too little protein ; by disorders of digestion, such as diseases of the stomach, the intestines, and the liver ; and by all influences that are injurious to the formation of blood from normal food, such as deficiency of exercise, of air, light, and heat, etc.

In all these cases, oligæmia almost never occurs in its simple form, the alteration in the blood being always of a complicated character. It is therefore, properly speaking, a bad practice to comprise the so very various conditions, belonging to this head, under the common name "anæmia." The physician should, in all cases, comprehend as definitely as possible the cause, its *modus operandi*, and the change in the blood which results from it, and regulate his treatment accordingly.

4. ANÆMIA PRODUCED BY THE CO-OPERATION OF SEVERAL, OFTEN OF A GREAT MANY, CAUSAL INFLUENCES.

§. 75. The forms of anæmia belonging to this head are very various, so that they cannot be enumerated. The following may serve as examples of them : anæmia from excessive mental and bodily labour, from continued excitement, pain. care, grief, and hardship ; anæmia from many acute and chronic diseases, some of which augment the consumption of blood, while others impede its formation—this effect being produced by any acute disease under certain circumstances, when its invasion is intense, and its duration sufficiently long ; but among chronic affections, it is chiefly caused by tuberculosis, cancer, diabetes, and the wasting diseases, &c. ;—and lastly anæmia from poisoning, by malaria (the so-called *malaria-chlorosis*), by lead and mercury (anæmia of miners and smelters).

Even in these cases of anæmia, simple oligæmia is very seldom produced. We most frequently meet with oligocythæmia, more rarely with hydræmia and serous plethora, and very often with intercurrent plethora ad vasa.

TREATMENT.

§. 76. In the treatment of symptomatic anæmia, the *discovery* and the *counteraction* of the *causes* constitute the main indication. Where the *cause* can be clearly recognised, its removal, if it can be effected, is generally sufficient for the cure.

If the cause cannot be removed, or the anæmia continues to be so considerable even after its removal, as to require special treatment, the following further indications should be fulfilled.

To promote as far as possible the supply of nutritive substances, and the formation of blood from them. This object is aimed at by nutritious diet, by roasted meat, broths, and red wine (if it agrees), in addition to fresh air, and residence in the country. Cinchona, with its various preparations, stands at the head of the pharmaceutical remedies.

Where the appetite is low, and digestion affected, they are to be promoted by stomachics, and bitter and aromatic medicines (tinct. cinchonæ composita, tinct. absinthii, infus. calami, bishop,* preserved ginger, etc.).

Ferruginous remedies are useful only when from a long persistent oligocythæmia a diminished energy of the formation of the blood-corpuscles may be inferred. They however often disagree, on account of great irritability of the vascular system, and a tendency to plethora ad vasa.

In hydræmia, the mode of treatment that has already been recommended should be employed in combination with an appropriate symptomatic treatment of the conditions which result from it.

The *prognosis* essentially depends upon whether the cause can be removed, or not. If this is impossible, a cure of the anæmia cannot be expected.

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* A favourite drink in some parts of Germany. It is prepared with red and white hock, sugar and orange peel. TRANS.

II. CHLOROSIS—GREEN SICKNESS.

§. 77. In chlorosis as in so many other morbid pro-
cesses obscure in their nature, a very indefinite idea
is associated with its name ; and much confusion
has been produced by attempts being made to im-
pose a simple name upon any case of disease that
occurs in practice, to insert it in some fixed division
of a nosological system, and to derive always from one
and the same cause all morbid symptoms which are
like one another. We shall reserve a further detail
of these circumstances for the section upon the theory
of this disease, but must premise here something at
least upon the extent and limit of the term chlorosis.

Many employ the name chlorosis precisely in the
same sense as anæmia, most French writers of our
time, for instance (Andral and Gavarret, Bouillaud,
and Cazin). Others distinguish between anæmia
and chlorosis in this way—they comprise under the
former name oligæmia from *known* causes, as opposed
to that arising from *unknown* causes, which they
regard as chlorosis (Becquerel and Rodier).

Others restrict the term chlorosis within still
narrower limits, and understand by it only that
form of anæmia which occurs in the female sex at the
period of puberty. This is the original, and, certain-
ly, the most unobjectionable mode of viewing it.

Chlorosis,* in its more *restricted* sense, would

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* The name is derived from χλωρος, pale, or greenish-yellow,
on account of the complexion of such patients.

therefore be that *spontaneous* form of anæmia (oligocythæmia, plethora serosa, etc.,) which generally arises without any distinctly demonstrable cause, and which is often observed in young girls at the age of puberty. In its *wider* sense, however, it would comprise, in addition to the cases named, others characterised by similar phenomena, which occur in the female sex before the development of its characters, or at a later period of life, as well as in the male. We might also establish it as a further distinction between chlorosis and symptomatic anæmia, though not a decided one, that the cause of the change in the blood is known in the latter disease, whereas it is generally unknown in chlorosis.

PHENOMENA OF CHLOROSIS.

The symptoms of this disease are very various. For facility of review, we shall arrange them in groups, and explain each of these groups as far as possible without the aid of too rash hypotheses.

§. 78. I. *Phenomena presented by the blood and the vascular system.* In all developed cases of chlorosis, an absolute or relative diminution of the red corpuscles is present. The relative oligocythæmia is sometimes so great, that 1,000 parts of blood contain 60, 50, or even 40 parts of dry corpuscles, instead of the normal mean number, about 130. Oligæmia (diminution of the volume of the blood-mass)

rarely exists. Most frequently a simple, relative
or absolute oligocythæmia, and often a serous ple-
thora are observed. The amount of albumen in the
serum is seldom diminished, often normal, and some-
times even augmented ; the serum showing an ex-
cess of water* in those rare cases only, in which
the disease is very obstinate, and severe. Very
frequently, plethora ad vasa supervenes. These va-
rious abnormal conditions of the blood develop, and
therefore often alternate with, one another. The blood
can be tolerably normal only at the very commence-
ment of the disease, when it is but faintly marked.
Such cases are however not properly chlorosis, though
they indicate a tendency towards it, and it is incorrect
to conclude from them that oligocythæmia does not
form an essential element of chlorosis, but that the
latter is a merely nervous disease.

The condition of the *vascular system* is very varia-
ble. Frequently, the pulse is slow, feeble, and soft.
The heart and the vessels are, however, in most cases
very irritable ; palpitation and irregular vascular con-
traction being caused by the slightest exertion, by walk-
ing or running, and by affections of the mind. The pal-
pitation becomes very often habitual, especially when
serous plethora is developed, and constitutes a very
constant and troublesome symptom. The irregular
and augmented movements of the heart and vessels
may induce plethora ad vasa, and disorders of the

* In 6 cases of chlorosis, Becquerel and Rodier found 72. 1 as the
mean amount of albumen in the blood, so that it was more than the
normal standard.

circulation, such as congestion in various parts of the body. They may, if they long persist, occasion an organic disease of the heart (hypertrophy and dilatation of the ventricles).

In most cases of chlorosis, the cardiac, arterial, and venous murmurs, described before (§. 66-70), are audible from the abnormal state of tension of the vessels and the valves of the heart. When the disease is well developed, murmurs are almost always present in the right jugular vein ; but they are frequently absent in the heart and the arteries. They are not always present, but may disappear for a longer or shorter period, and then reappear, thus proving that they are not, as has been maintained, the direct physical effect of the altered condition of the blood (relative oligocythæmia), but are produced by it in a circuitous way, through the medium of the nervous system.

§. 79. II. Phenomena presented by the *surface of the body—complexion—temperature.* A change in the complexion constitutes the most striking symptom of chlorosis, and has even given the name to the disease. It is a *marked pallor* of the skin, which is sometimes perfectly pale, at other times yellowish, greenish, or wax-coloured, from the predominance of the colour of the pigment of the skin. The lips and other visible mucous membranes are also pale. This symptom is an effect of oligocythæmia, and is always present in the fully developed disease. It may, however, disappear for a moment, and give

place to a transitory redness, if from any cause a general or local affection of the vessels, a hyperæmia of the parts in question, arises. Further, it may be absent in the beginning of the disease, when the oligocythæmia is just developing itself, and has not made much progress.

In some cases with considerable serous plethora, or with a hydræmic state of the blood, slight dropsical swellings are observed ; such as œdema of the feet and the ankles, the face and the eyelids. Frequently, the patient· presents a blue halo around the eyes.

The temperature of the body is generally diminished ; the breath cool, the lips, nose, ears, hands, and feet cold. The patient readily feels chilly, is sensitive to external cold, and seeks warmth.

§. 80. III. The phenomena presented by the *nervous* and the *muscular* system, are also usually very well-marked in chlorosis, as in oligocythæmia generally. The patient suffers from great prostration and debility, and is tired by the slightest exertion. The weakness sometimes becomes so great, as to lead to fainting. Yet chlorotic subjects may occasionally, when they are excited, hold out against considerable efforts, and dance for whole nights, etc.

Two causes co-operate in the production of these symptoms : viz., oligocythæmia, and the primary or secondary diminution of the energy of volition (hysteria) which is observed in cases of chlorosis.

The *sensitive* portion of the nervous system is generally deranged, as well as the intelligence, and the functions of the organs of sense. The patient frequently suffers from vertigo, head-ache (clavus, hemicrania), tinnitus aurium, especially in the right ear, sparks in the eye, a tendency to fainting, and from pains in various parts of the body which may pass into neuralgia, especially from gastrodynia, and pains in the back (spinal irritation). Sometimes, hysterical convulsions make their appearance.

The mind is often affected, as is indicated by a tendency to grief and despondency, frightful dreams, the apprehension of the night-mare, melancholia, and sometimes even mania and a suicidal tendency— (Marshall-Hall, Cazin).

These phenomena have likewise various sources, and a manifold signification. Some of them are results of the abnormal condition of the blood, and of the disturbances in the circulation and nutrition of the brain and spinal cord produced by it : they are met with precisely in the same manner as in cases of symptomatic anæmia. Others are caused by primary changes in the nervous system, accompanying or complicated with chlorosis, by hysterical derangement, etc. ; they are therefore not effects, but complications of oligæmia. Indeed, these symptoms sometimes precede the commencement of anæmia, and must even be regarded as its causes. Many of them have special sources. Thus, tinnitus aurium sometimes seems to be merely a perception of the vascular murmurs ;

and the gastrodynia appears to be frequently caused by a co-existing ulcer in the stomach.

§. 81. IV. The phenomena presented by the *digestive* and the *respiratory organs,* and by the *metamorphosis* of tissue. *Disorders of digestion* are not unfrequently met with in chlorosis. The appetite is diminished ; digestion becomes slow and troublesome, and the patient complains of a foul, acid eructation. Frequently, the appetite is perverted ; some articles of food, especially of animal food, being refused, others acid and high flavoured craved for. These longings may grow into pica and malacia, i. e., into a desire to eat non-alimentary substances, as chalk, paper, ashes, coal, plaster of Paris, and even excrements ; or into an immoderate increase of the appetite, into actual voracity (bulimia). Things very difficult of digestion, as pork, pulses, heavy farinaceous food, sourcrout, etc., are often in a remarkable manner borne better by chlorotic patients than easily digestible substances, such as light soups, light animal food, etc. Very frequently, there are pains in the region of the stomach and distension and tenderness of the epigastrium passing into violent gastrodynia. They sometimes co-exist with tenderness of the dorsal vertebræ. In chlorosis, the bowels are often constipated.

These phenomena presented by the organs of digestion, are entirely absent in many chlorotic individuals. They seldom seem to be the *effect* of the alteration in the blood, which sometimes produces indirectly, first

spinal irritation, and then pains in the stomach. They are, in most cases, caused by a primary affection of the organs of digestion, which is sometimes nervous in character, and sometimes arises from material changes that are anatomically demonstrable (gastric catarrh and ulceration, etc.). These disorders of digestion are amongst the simple complications of chlorosis ; but in many instances they are the primary affection, and the *cause* of the disease. Assimilation and sanguification become defective from the aversion to nutritious food, or from disordered digestion, and anæmia is the ultimate result.

In chlorotic subjects, *respiration* is also often deranged. They readily become breathless, especially on exertion, during the ascent of staircases, and in the act of running ; they frequently sigh, and occasionally cough. These symptoms evidently depend, in most cases, upon the nervous system, the anæmia contributing only indirectly to their production, by its action upon the latter.

Our knowledge of the *metamorphosis of tissue* in chlorosis is very incomplete and defective. The urine is pale, and light coloured, probably indicating very slight transformation of the blood-corpuscles. In the chlorotic, there also appears to be little metamorphosis of the muscular tissue. They seem to generate less heat, and accordingly to consume less oxygen. The tissue-change is also probably abnormal in the nervous system. All these relations, however, need still further elucidation, by means of a more extended series of investigations.

§. 82. V. Phenomena presented by the *genital system*. In chlorosis, the genital system presents great anomalies. Menstruation is generally absent, or, at least, irregular and painful, or thin and watery. Very frequently, it is replaced by leucorrhœa.

Amenorrhœa and dysmenorrhœa are, in by far the greatest number of cases, not the *cause* but the *effect* of chlorosis. The maturation of ova, and their periodical extrusion which is accompanied by hæmorrhage, are prevented by anæmia and the nervous derangement. Yet in rare cases, primary affections of the uterine system, involving amenorrhœa and dysmenorrhœa, may produce chlorosis. This is, however, an exception to the rule.

Menstruation is sometimes very copious. This may be viewed in two different lights. An abundant watery menstrual hæmorrhage may result from serous plethora co-existing with a moderate degree of chlorosis, in which menstruation does not entirely cease ; or profuse menstruation may, like any other loss of blood, cause anæmia. In the latter instance, the disease is not so much chlorosis as symptomatic anæmia. In both cases, but chiefly in the latter, menstruation usually aggravates the symptoms of the disease.

§. 83. From the preceding sketch it is evident that many of the symptoms, usually accompanying chlorosis more or less regularly, are to be regarded as results of anæmia ; and that others, on the contrary, are more or less accidental complications.

Another circumstance, which is not unfrequently remarked, deserves special consideration from its great practical importance. It is the frequent absence of striking symptoms in chlorotic patients for a long while. They are affected with distinct chlorosis for weeks, and even for months ; yet they feel themselves, apart from some lassitude and palpitation of the heart, tolerably well, and can perform their usual occupations, though with difficulty ; the disease being so gradually produced, that the system adapts itself to the change in the blood, and becomes in a certain measure accustomed to it. But if they be suddenly attacked with however slight an acute intercurrent disease, with a catarrhal, gastric, or rheumatic fever, etc., important symptoms immediately ensue, bearing no proportion to the intensity of the intercurrent affection. A very considerable excitement of the heart and the vascular system is produced, the disease itself assumes a peculiar, lingering course, a so-called mucous fever occurs, the convalescence becomes protracted, and complete recovery results only from remedies which are capable of removing anæmia (compare §. 65.)

CAUSES OF CHLOROSIS.

§. 84. The *causes* of chlorosis are very various, and, in many cases, difficult to discover or entirely unknown. Even where they are demonstrable, many trifling causes generally co-operate, often so many, that it is difficult to state the share of each. For

facility of review, the causal influences may be arranged in certain groups. They may be distinguished into :—proximate and remote ; predisposing

PREDISPOSING CAUSES.

Sex and *age*. The occurrence of chlorosis in the male sex has often been a matter of dispute. This dispute had some meaning in it, as long as diseases were deemed independent existences, parasites or pseudo-parasites, which were classified, like animals and plants, into distinct genera and species ; but as it is now generally understood that diseases are not independent existences, but merely deviations from the normal condition of the organism, the decision of this question is unimportant. It is certain, that spontaneous anæmia occurs also in males, though much more rarely than in females, generally arising from unknown causes, with all or most of the symptoms of chlorosis. Whether these cases are to be regarded as chlorosis, or distinguished from it and designated by another name, is quite an arbitrary question, and depends upon the latitude allowed to the term " chlorosis." Cabanis, Désormeaux, Copland, Blaud, and others, have described such cases. Of 160 cases of chlorosis Cantrel found that 142 were females and only 18 males.* The more frequent occurrence of oligocythæmia, and consequently of

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* For particulars, *vide Cazin*, p. 20.

chlorosis, in females than in males, is no doubt owing to the blood of females being usually poorer in corpuscles, or rather to the tendency to the formation of blood-corpuscles being less in females, and therefore more readily subject to disturbances than in males.

It is a precisely similar question whether chlorosis can occur at *any age*. The disease, no doubt, occurs most frequently during or soon after the development of puberty. But we also meet with cases in children and in older women, which resemble chlorosis in every respect. Cantrel has given a statistical synopsis of 138 cases of chlorosis in females, according to age. According to it, there occurred,

under	15 years			14	cases
between	15 and 20 years			64	,,
,,	20	,,	25 ,,	36	,,
,,	25	,,	40 ,,	16	,,
,,	40	,,	57 ,,	8	,,

$$\overline{138}$$

I have also not unfrequently seen chlorosis with all its characteristic symptoms in girls of from 8 to 15 years old. In the male sex, chlorosis occurs at all ages between 5 and 57 years (Trousseau and Blaud).

Temperament. The lymphatic temperament, in which the blood-corpuscles are below the physiological mean, is the most predisposed to the disease. Next to it is the nervous, and still more a combination

of the two. The sanguineous is much less so. A
feeble constitution is also a predisposing cause of this
affection.

Climate and *season* seem to be without influence ;
but the *mode of living,* and the *diet,* etc., exercise an
important effect. Sedentary life, indolence, deficiency
of fresh air, emotions, and grief ; and the opposite
conditions, excessive labour and hardship, are among
the more frequent predisposing causes.

EXCITING CAUSES.

There is, of course, no well defined limit between
these and the predisposing causes. Many influences
act sometimes more in the one way, sometimes more
in the other ; as improper mode of living ; inap-
propriate, insufficient, hardly digestible, or insipid
food ; immoderate use of mucilaginous things, and of
farinaceous aliments ; in short all substances which in-
jure nutrition and sanguification in the manner already
described.

Further, all things which first excite the nervous
system, and then relax it as well as the muscular
system, operate sometimes as predisposing, some-
times as exciting causes ; such as immoderate use of
tea and coffee, of warm baths, etc.

It has already been mentioned, when treating of
the symptoms, that *chronic disorders of digestion*
are sometimes to be regarded as the true cause of
chlorosis. Here Hannon's view should be stated.
He believes, that in chlorosis more than an ordinary

amount of sulphuretted hydrogen gas is generated in the intestines ; and that this precipitates iron from the dissolved constituents of the food, and causes it to be eliminated with the fæces in an insoluble condition, as sulphuret of iron. The chyle is thus, in his opinion, poor in iron, and the formation of blood-corpuscles consequently defective. Whether this view is correct or not, as regards individual cases of chlorosis, is a question which still remains to be proved. That it is not adapted for the explanation of all instances is, however, beyond doubt.

Various other circumstances, which have been regarded as causes of chlorosis, such as disorders of menstruation, pregnancy,* suckling, the action of corrupt air surcharged with carbonic acid or coal-smoke, etc., may co-operate in individual cases, but are seldom·the main cause.

Psychical influences act somewhat more frequently as predisposing and exciting causes. These are fear, terror, care, home-sickness, ennui (?), unsuccessful love, masturbation, etc. Any one of them, however, rarely produces chlorosis by itself.

FREQUENCY, COURSE, AND DURATION.

§. 85. Chlorosis is a *very frequent* disease, and though precise statistical statements are still wanting as to the percentage it forms of all existing diseases, yet this much is certain, that it constitutes a large

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* *Cazeaux*, de la chlorose pendant la grossesse. Revue Méd. 1851. Mai, Juin, Juillet.

portion of all chronic affections which occur in females, especially at the age of from 16 to 25 years.

It generally arises and runs its course in a *chronic* manner, and is of long duration, lasting for months, and even for years. It has a great tendency to relapse after its cure.

It is almost always *complicated*, i. e., what we call chlorosis is a complication of oligæmia with various other conditions, as has been already mentioned under the head of symptoms.

THEORY OF CHLOROSIS.

§. 86. Much of what belongs to this place has been already mentioned. Here the main points will be reviewed in connection with one another, and some will be treated of more in detail.

In the first place, it seems important to make the distinction between chlorosis and the other forms of anæmia clear, and to establish it on a solid foundation.

In anæmia, the causes which effect a diminution of the blood-corpuscles, though in very various ways, and thus produce the disease, are positively demonstrable.

In chlorosis, these causes are either unknown, or slight, and obscure causal influences can alone be demonstrated, which generally produce a diminution of the blood-corpuscles, not directly but indirectly, in a circuitous way. Usually, many causes seem to co-operate, and to produce the effect only in a state

of combination ; none of them being capable of doing so by itself.

The distinction between anæmia and chlorosis is, therefore, only relative or rather subjective, and not well marked and decided. It is immaterial, and will always depend upon caprice, whether individual cases, or whole groups of cases, malarious chlorosis for instance, and the chlorosis of the colliers of Annecy, etc., be reckoned as chlorosis, or as anæmia. Many instances, now regarded as chlorosis, from their cause being not evident, will probably be enumerated as anæmia at some future period, when their cause shall be more precisely known.

Chlorosis most frequently occurs in the female sex, at the age of puberty. At this period, a considerable change takes place in the female organism. The generative apparatus develops and prepares itself for its functions, and the whole system is at the same time modified ; so that it is conceivable, although not quite evident, that disorders of sanguification leading to anæmia may at that time easily occur. If the energy of the formation of blood-corpuscles from the albumen be impaired, as is commonly the case, then oligocythæmia is produced together with hyperalbuminosis and serous plethora ; but if the formation of albumen be diminished, hypalbuminosis and hydræmia ensue.

The starting-point is different, according to the predisposing and exciting causes that are present. Very frequently, the disease originates in the nervous system. This is deprived of its necessary

energy, and thus are impaired the appetite and diges-
tion, causing secondary anæmia. Cases of this kind,
in which nervous disturbances precede the alterations
in the blood, have led to the belief that chlorosis is
a nervous disease. This view may be correct in
individual cases, but not in all ; and even when it is
so, it is only a one-sided view which can overlook
the anomalies of the blood in the nervous disorders
that are present, more especially as in fully developed
chlorosis most of the disturbances of the nervous sys-
tem are caused by the altered condition of the blood.

The error of explaining all cases of chlorosis by
one and the same cause, is very often committed, not-
withstanding that the etiological relations are usually
very complicated ; for not only may different causes
operate in different cases, but generally several
causes are in operation at the same time, so that it
is difficult, in most instances, to determine the exact
influence of each.

An evident cause is distinctly marked only in
isolated cases ; but whether this cause be disorders
of digestion, ulcers in the stomach, profuse men-
struation, insufficient food, or any other circumstance,
any theory founded upon it, that of Hannon's for
instance, must necessarily be partial, as it attempts
to explain all cases of chlorosis by one and the same
cause. Moreover, those cases that are produced by
even a *single* well-known cause, belong more to
symptomatic anæmia than to chlorosis.

The connection and the causes of the individual
symptoms have, for the most part, been already

pointed out, while treating of them separately. They are produced either by anæmia, or by other influences; so that chlorosis is evidently a very complex disease.

Although most cases of chlorosis occur in the female sex, at the age of puberty, for reasons mentioned above, yet the same causes may operate, more rarely however, at other periods of life, and in the male sex—many trifling causes which by their co-operation produce, not only anæmia, but many other collateral symptoms, so that the result is not simple anæmia, but a complicated disease. It is not only theoretically correct to distinguish these morbid forms from true anæmia, and to consider them as chlorosis, but also practically so, as they require a special treatment.

DIAGNOSIS AND PROGNOSIS.

§. 87. The *diagnosis* is obtained from the signs of anæmia, in combination with the various complications mentioned before. In well-developed cases it is easy. Chlorosis cannot be confounded with *icterus*, except by a careless physician. It is, however, more easily mistaken for organic diseases of the heart; but even here long-continued observation, and a minute examination of the heart will ensure the diagnosis. The diagnosis is more difficult at the commencement of the disease, when anæmia has not yet been developed, and obscure nervous phenomena are perhaps all that can be observed

It is often difficult to distinguish a slight degree of chlorosis from incipient pulmonary tuberculosis.

Though the disease is generally of long duration, and has a tendency to relapse, yet the *prognosis* is usually favorable. Chlorosis is seldom dangerous ; when severe, it may however lead to death. Fatal cases have been described by Marshall-Hall, Barclay, Cazin, and others.*

THERAPEUTICS.

§. 88. The treatment of chlorosis must, of course, be conducted according to the same principles as that of anæmia generally. Yet in chlorosis, the *indicatio causalis,* which is so important in symptomatic anæmia, can rarely be fulfilled in a satisfactory manner, either because the causes are often not sufficiently evident, or because they are numerous and complicated. All that the physician can do is to endeavour to remove them as much as possible.

The proper treatment of chlorosis may be divided into dietetic and pharmaceutical. There is, besides, the treatment of the most important complications.

1. DIETETIC TREATMENT.

§. 89. The dietetic treatment of chlorosis constitutes, in most cases, our main task. It is sometimes alone sufficient for the cure, effects the most thorough

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* *Cazin,* loc. cit. p. 45; *Barclay,* Death from anæmia.—Medical Times, May, 1851.

recovery, and secures best against relapses. Its chief indication is so to regulate all the functions of the patient, as to remove the existing obstacles to normal sanguification, as well as the complications that are present. From its very nature this treatment must be adapted to individual cases, which however cannot always be done to our satisfaction. The matters connected with it are so uncommonly various, as not to admit of a detailed description in this place. The following points deserve our chief consideration :—

Attention to healthy residence, and to fresh, pure air : hence the necessity under certain circumstances for a change of residence into the country, in the case of inhabitants of towns.

Proper exercise. This must, on the one hand, aim at an augmentation of the metamorphosis of the muscular tissue, and consequently at an improvement of sanguification, (especially in serous plethora), and must, on the other hand, strengthen the energy of volition. When the disease is at its height, exercise is frequently not at all tolerated, but increases the palpitation of the heart and promotes congestion ; so that it must be performed with great caution and strict regularity. In such cases, I have seen benefit from daily repeated, methodical exercise of the arms, and from other partly passive, partly semi-active movements, regulated in the manner taught by the therapeutics of motion. More powerful exercises in the open air, such as the game at tennis, the hoop, and other plays, travelling on foot, long walks, etc., serve as a prophylactic at the commencement of the disease, and

are towards its termination very well adapted to promote convalescence, and to prevent relapse. They should however be carefully regulated lest they do more harm than good.

Dry friction of the back and limbs, and aromatic liniments are very useful. Cold rain-baths and douches, sea-bathing, etc., require greater precaution, but when they can be borne, they often operate very favorably, and may even cure very inveterate and extreme cases of the disease, (compare Fleury de l'emploi des douches froides excitantes contre la chlorose et l'anémie. Archives génér. Janvier. Févr, 1851.)

Tepid baths generally do not act favorably. The same remark also applies to chalybeate baths, whose employment is neither so sovereign nor so harmless a remedy, as many hydropathic doctors suppose it to be.

The regulation of the food, the digestion, and the bowels require special attention. The food ought to consist of simple articles, among which meat is the most important. It must neither be too stimulating nor too bland and abundant. If strong broths, and meat, especially roasted beef, agree, they always deserve the preference, but the patient's aversion, or gastric complications, very often form an obstacle to their use, in which case we must select the most appropriate food which circumstances will permit. Frequently chlorotic patients cannot bear wine, from its augmenting the existing irritability of the vascular system ; but if it can be borne, it may be taken

with advantage. In such cases, the stronger astringent red wines are especially to be recommended, either alone, or in combination with bitter remedies (as bishop). The bowels which are frequently costive are sometimes restored to a natural state by proper food and mode of. living ; otherwise, they require the use of appropriate pharmaceutical remedies.

A due action upon the *mind* of the patient, is of great · importance. If any unfavorable influences operate powerfully on it, such as care, grief, unsuccessful love, masturbation, and the like, they must be combated. It is also desirable, in other cases, to counteract the mental relaxation or the nervous irritability, from which such patients often suffer, and to exalt their mental energy as much as possible.

2. PHARMACEUTICAL TREATMENT.

§. 90. In almost all cases of chlorosis, pharmaceutical remedies are useful, if applied according to correct indications ; in many instances, they are even necessary.

Iron, with its various preparations, is our chief medicine. In chlorosis, ferruginous preparations seem to act chiefly by promoting the formation of the red blood-corpuscles from the albumen of the blood-serum. This explains the fact, acknowledged by all observers, that iron operates most favorably in those cases of anæmia in which the blood, though poor in corpuscles, is rich. in albumen (as in true chlorosis and serous plethora) ; while in

anæmia after loss of blood, the chief indication is to restore by abundance of nutritious food the albumen from which the corpuscles are afterwards regenerated of themselves, without the use of iron.* Iron seems also to act favorably by removing the atonic weakness of digestion, so frequently observed in chlorotic individuals. It is certain that, in most cases of chlorosis, absolute and relative oligocythæmia are gradually diminished under the use of iron, for which innumerable prescriptions and formulæ have been given, though none of them deserves the preference over the others, in all or even in the majority of cases. For several years I have made extensive series of experiments upon the action of various preparations of iron in chlorosis, and have found that powdered steel, lactate of iron, malate of iron, and sulphate of iron, act equally well, either by themselves, or the last in combination with carbonate of potash (in the form of the so-called Blaud's pills). It is therefore, in many cases, immaterial which of the numerous officinal preparations of iron, or of the reputed domestic and popular chalybeate remedies, (powdered steel, protoxide of iron, hydrated sesquioxide of iron, lactate of iron, citrate of iron, acetate of iron, malate of iron, phosphate of iron, sulphate of iron, or the more compound preparations, ammonio-chloride of iron, tinctures of iron, wine of iron, sulphate of iron with

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* According to Becquerel and Rodier, in chlorosis 1,000 parts of blood contain, on an average, 86 parts of corpuscles, and 72.1 of albumen ; in symptomatic anæmia 94.7 of corpuscles, and only 68 parts of albumen.

carbonate of potash, (Blaud's Pills), etc.) be selected. In others, however, the choice must be determined by individual circumstances. In vain young girls, preference may be given, for cosmetic reasons, to the insoluble over the soluble preparations, to powdered steel, hydrated sesquioxide of iron, etc., over acetate of iron, malate of iron, sulphate of iron, etc. ; the teeth readily acquiring a black colour from the use of the latter remedies. The employment of chalybeates in too large doses is to be avoided ; because they unnecessarily burden the organs of digestion, and pass off for the most part with the stools, either unchanged, or as sulphuret of iron. Doses of 1—2 grains, two or three times daily, are quite sufficient, and more than 10 grains should not be used in the 24 hours, even when it is desirable to supply as much iron to the system as possible. We should however continue their use for a long time, for several months, and even after the cure has been effected ; because, otherwise, the disease is apt to relapse. During the employment of ferruginous preparations, the use of acid substances (vinegar, salad, sour milk, etc.) is commonly prohibited ; this precaution seems necessary because the compound formed by the combination of oxide of iron with albumen, under which form in particular iron appears to be absorbed by the intestines, is soluble in alkaline, but not in acid fluids, (B. G. Mitscherlich.)

For the cure of chlorosis, chalybeate natural and artificial *mineral waters* may be used instead of the various pharmaceutical preparations of iron.

The *external* application of iron, in the form of natural and artificial chalybeate baths, seems to be but little adapted to supply a considerable amount of that substance to the system. Such baths may serve as prophylactics, and as accessory remedies ; but they cannot be a substitute for the internal use of iron.

The statements made in our own times that iron can cure chlorosis by mere *contact*, on being applied to the skin or the intestinal canal,* must first be confirmed by further investigations, before science and practice can take notice of them.

During the last few years, preparations of *manganese* have been recommended as remedies for chlorosis from different quarters, especially in Belgium and France.† The advocates of this remedy have started from the fact that besides iron the blood contains also manganese (1000 parts of normal blood containing 1.2—1.3 of iron and 0.06—0.07 of manganese), and that in chlorosis the amount of both these substances is diminished, (Burin de Bouisson found in 1000 parts of the blood of a chlorotic girl only 0.5 parts of iron and 0.025 of manganese,) so that not only the deficiency of iron but also that of manganese requires to be supplied to the blood. For this object, dozens of pharmaceutical preparations containing iron and

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* *Burq*, sur une application nouvelle des métaux à l'étude et au traitement de la chlorose. Gaz. Méd. 1852, Nos. 29, 31.

† *Hannon*, de l'emploi thérapeut. du manganèse. Revue Méd. Chirurg. Juin, 1849 ; *Burin de Bouisson*, mémoire sur l'existence du manganèse dans le sang humain, etc. Révue Méd. 1852, Fevrier, Mars, Août; *Pètrequin*, nouv. rech. sur l'emploi thérap. du manganèse. Bullet. de therap., 1852, Mars.

manganese at the same time (sulphate, carbonate, citrate, lactate, and other salts of manganese and iron) have already been made and used. The advocates of these compound remedies assure us that they act very favorably. It is however impossible to determine how much of their action is due to iron, and how much to manganese ; so that in most cases of chlorosis, the simultaneous employment of manganese seems unnecessary ; preparations of iron being alone suffi-cient for the cure. Another more important practical question is, whether those obstinate cases of chlorosis can be cured by manganese which always relapse in spite of the use of iron, as is maintained by Hannon, Delorme, and others ? For the decision of this question, I have given manganese for weeks in some obstinate cases of chlorosis, which had, in vain, been treated with iron for a long time, but have seen no decided result from it in even a single case. These trials, which have however not been numerous, do not lead me to attribute much efficacy to preparations of manganese. Manganese may however always be tried in combination with iron in the treatment of those cases of chlorosis in which the iron is not alone sufficient for the cure.

Hannon maintains (Gaz. Med. 1851, Août), that lead, copper, zinc, and bismuth, cure chlorosis just as well as iron or manganese ; and that these remedies are useful in some cases, where both iron and manganese fail. This is explained by him in the following manner. Ordinary food contains a sufficient amount of iron and manganese to meet the requirements of the blood

But during digestion sulphuretted hydrogen is formed in the intestines, which decomposes the compounds of iron and manganese, and converts them into sulphurets of the metals, so that they pass off with the stools undissolved, and are thus, as it were, withdrawn from the blood. This is especially the case in chlorosis. It is however prevented by the administration of a non-poisonous metal which combines with the sulphuretted hydrogen, and thus permits the iron to form a soluble compound, capable of being absorbed into the blood. It has been remarked above (§. 84), that this supposed cause is, in the majority of cases, not the only, nor the chief source of chlorosis. But even in those cases, where we might have reason to assume this mode of origin, the use of preparations of iron is in practice preferred to that of the other metallic salts, because iron combines with the surplus sulphuretted hydrogen just as well as those other metals, and the deficiency of iron in the blood can certainly be best supplied by giving that metal.

Bitter remedies (gentian, wormwood, preparations of cinchona, etc.,) stand next, in efficacy, to preparations of iron, in the treatment of most cases of chlorosis; but they are used with advantage in combination with chalybeates, on account of the atonic weakness of digestion that is present.

Many old physicians, from the time of Hippocrates to that of Fr. Hoffmann, have recommended *abstraction of blood* in individual cases of chlorosis. In more recent times, we regard chlorosis as nothing but oligocythæmia, and are blind to almost all

the other phases of the disease, so that this remedy has been entirely rejected, and declared to be absolutely injurious. This view is very incorrect. In those not unfrequent cases, where a high degree of serous plethora exists in chlorotic individuals, and produces violent excitement of the vascular system, palpitation of the heart, and congestion in the head, venesection not only acts palliatively as a sedative, but also facilitates the radical cure of the disease, inasmuch as it causes the subsequently administered ferruginous preparations to be borne more easily than if the serous plethora were not checked. In such cases, I have never seen any harm from general or local abstraction of blood, but have often derived great benefit from them. We must however make them as small as possible, a couple of ounces being generally sufficient ; and must employ them only in those cases, where the just-mentioned indications are present.

3. TREATMENT OF THE COMPLICATIONS.

§. 91. The numerous and very various complications, which may be present in chlorosis, require very different modes of treatment, which must be adapted to individual cases. In the following account only the most frequent and important of these complications can be considered, as well as those in whose treatment physicians most often proceed upon incorrect principles.

Amenorrhœa especially belongs to the latter class. It has already been mentioned, that this disease is

generally the effect, very rarely the cause of chlorosis. Hence, in the majority of cases, it is better to employ no emenagogues at all, or to use them only if the menses do not appear of themselves, after the cure of chlorosis has been effected.

Constipation constitutes a frequent complication of chlorosis. It seems to arise from atony of the intestines, and diminished peristaltic movement dependent upon the atony. In most instances, it disappears under a judicious dietetic treatment, and the use of iron. In chlorotic patients, the latter remedy, instead of increasing the constipation, usually acts as an aperient. If the constipation continues, mild purgatives should be given, as small doses of jalap, rhubarb, colocynth, or aloes, in combination with the iron. In serous plethora, chalybeate saline mineral waters (those of Soden, etc.) deserve the preference. The too free, or the too long-continued use of purgatives is injurious, as it increases the torpor of the bowels.

The *pains* and *hysterical* and *nervous* symptoms which are so frequently present, occasionally call for the use of narcotics. Yet, in the use of these remedies, it must not be forgotten, that their efficacy is only temporary ; and that their employment for a long time, or in large doses, alters the metamorphosis of tissue in the nervous centres, and thus rather augments than diminishes the disposition to nervous irritability.

Where, from the intensity and long duration of the *gastralgic* symptoms, as well as from the inefficacy of narcotic remedies to remove them, we are led to suppose

that material changes are present in the stomach (chronic gastritis, ulcus ventriculi simplex), we should direct our special attention to the regulation of the diet, and cautiously administer those remedies which may promote the healing of erosions and ulcerations of the gastric mucous membrane, such as the nitrate of silver, trisnitrate of bismuth, sulphate of iron, and muriate of iron.

THIRD GROUP.

ABNORMAL ACCUMULATION OF NOXIOUS MATTERS IN THE BLOOD.

§. 92. In a large class of diseases the composition of the blood is disturbed by the accumulation of matters in it, which, somehow or other, act injuriously ; their action being sometimes mechanical like that of foreign bodies, sometimes chemical, and sometimes a combination of both. These noxious matters may be introduced into the body from without, already prepared, such as poisons, contagions and miasmata ; but they may also arise within the body itself, from pathological changes in the metamorphosis of tissue, or from the retention of substances by disease which, though they are produced in the normal condition of the system, are then always eliminated.

The diseases, appertaining to this group, are almost all still rather obscure, in a scientific as well as in a practical point of view. Attempts have however been made to trace some of them back to certain elementary morbid states, (uric acid and oxalic acid diatheses, etc.) ; while in others, very different conditions, which are not accurately known, are comprised under a common name (status putridus, pyæmia, etc.).

There are many diseases, most contagious ones for instance, such as measles, scarlatina, small-pox, syphilis, etc. which, though they no doubt belong to this class, being produced by the introduction of a foreign body into the blood, are yet not usually reckoned as blood-diseases, because their main symptoms occur in other parts of the body. There are others, such as diabetes mellitus, uræmia, etc., in which changes in the character of the urine play an important part, or at least form a main symptom. They are therefore commonly enumerated with the diseases of the uropoietic system.

We shall in the first place give a short abstract of those alterations in the blood belonging to this group, which already possess or will, in all probability, soon acquire a practical importance, and then consider more minutely some of the diseases which probably depend upon them.

SUGAR IN THE BLOOD (MELITÆMIA).

§. 93. A considerable portion of the substances taken as food, either already contains sugar, or is converted into it within the system. This sugar undergoes further changes in the body, the final result being the formation of carbonic acid and water. Sometimes, however, this further decomposition (combustion) does not take place, or takes place only partially ; and sugar (grape-sugar) accumulates in the blood, and passes into the secretions, especially into the urine. As, however, the amount

of sugar in the blood plays but a subordinate part in this event, which should rather be viewed as a disease of the metamorphosis of tissue than otherwise ; and as, moreover, the most striking symptoms of the malady, which are of the highest importance in its diagnosis, depend upon the passage of the sugar into the urine, this disease (diabetes mellitus) ought to be described among the affections of the uropoietic system.

ACID DIATHESIS (OXYÆMIA).

§. 94. Bence Jones supposes that the so-called elements of respiration of Liebig, that is to say, the amylaceous substances, (starch, gum, sugar, etc.), instead of being finally transformed into carbonic acid, are in certain diseased states converted into lactic acid, and in that form retained in the system for a long time. This morbid action would diminish the alkalinity of the blood (compare §. 43), and probably produce many changes in the metamorphosis of tissue. It however has not as yet been positively demonstrated; so that its assumption is a mere hypothesis. But as this hypothesis, if confirmed, would have a great practical importance, and is, moreover, such as may be proved or disproved by investigation, a mention of it does not seem quite uncalled for here, especially with the view of stimulating to further investigations.

URIC ACID AND OXALIC ACID DIATHESES.

§. 95. From alterations in the metamorphosis of tissue, still for the most part veiled in obscurity, more

uric or oxalic acid is generated in the system than in the normal condition. These matters accumulate in the blood, and give rise to symptoms of disease. Both conditions will however be subsequently described among the diseases of the uropoietic system, because their diagnosis and the most important effects of their presence are less manifest in the blood than in the urine.

AMMONIA, SULPHURETTED HYDROGEN, AND ANALOGOUS SUBSTANCES IN THE BLOOD.

§. 96. There are many reasons for believing that, in certain not very rare cases, carbonate of ammonia, hydro-sulphate of ammonia, and analogous substances, may occur in the blood, alter it, produce symptoms of disease, and, under certain circumstances, even death itself. This fact has been mentioned above, when treating of the dissolution of the blood-corpuscles (§. 21), and we shall again return to it, under the head of putrid fever and status putridus. It seems, however, appropriate to consider it here more especially, while treating of the elementary alterations in the blood, in order to direct the attention of physicians to it, so that none of the opportunities be neglected, which but seldom present themselves in the living subject, of studying the higher degrees of this change.

The following are some of the results of the numerous investigations I have made upon this subject, but which unfortunately I have not yet been able to bring to a definite conclusion.

Human blood, being left to itself for some time, always develops ammonia and sulphuretted hydrogen ;—at least, very numerous experiments have invariably yielded this result in my hands. Ammonia and sulphuretted hydrogen gas seem, therefore, to be *constant* products of the spontaneous decomposition of the blood.

The formation of these products commences sometimes early, sometimes late. In some cases, no signs of their presence could be found even after a week, while in others they could be distinctly demonstrated after twenty-four hours. They are observed first and most readily in preserved defibrinated blood, then in coagulated blood (cruor), and last of all in the serum that is separated. An elevated temperature, even one not so high as that of the human body, (72·5° to 75° Fahr.), always promoted this process, but a low temperature prevented or retarded it. The formation of ammonia usually began earlier than that of sulphuretted hydrogen.

In the blood of dead subjects, I could sometimes detect the presence of ammonia and sulphuretted hydrogen during the post-mortem examination, (sometimes only 12 hours after death) ; in other instances, this could be done only after several days. Hence it follows that the tendency to the decomposition of the blood varies in its strength in different cases. In the living body, I have not yet succeeded in detecting these substances, and so far the investigations are still defective. I do not, however, doubt that we shall one day succeed, so that an

examination of the blood with reference to these two substances must not, in my opinion, be neglected in cases that seem adapted for the purpose. In well marked cases the detection is easy. The half of an opodeldoc-glass is filled with blood, and a glass-rod, moistened with non-fuming sulphuric acid, held in its upper and empty part ; if ammonia be present, whitish vapours are immediately formed. To detect sulphuretted hydrogen, a small piece of paper, wetted with a solution of acetate of lead, is inserted between the glass and its stopper, and suspended in its upper and empty part. If sulphuretted hydrogen be present, the paper assumes a dark-lead colour after a short time.

That the admixture of ammonia or sulphuretted hydrogen with the blood in a tolerably large quantity proves fatal, is a well-known fact. Their action seems to depend upon a destruction and dissolution of the blood-corpuscles, which were always found dissolved to a greater or less extent whenever one or the other of those substances was produced during the spontaneous decomposition of the blood. Small quantities of them, however, destroy only a few of the blood-corpuscles, so that life is saved, notwithstanding the occurrence of disorders of health ; the products of decomposition being eliminated by the secretions.

It is possible, nay even probable, that other volatile products to which the effects are in some measure due are formed together with the ammonia, as well during the spontaneous decomposition of the blood,

outside the body, as within it, in case of disease. Compare Schlossberger at the conclusion of an article upon the sausage-poison. Archiv für physiolog. Heilkunde. Supplement, 1852.

URINARY CONSTITUENTS IN THE BLOOD (URÆMIA).

§. 97. In many instances, the products of the metamorphosis of tissue, which are in the normal condition eliminated by the urine, especially urea, are retained in the blood, either totally or partially, and cause disturbances by their presence, or by undergoing further changes. According to Frerichs' view, these disorders depend upon the conversion of urea into carbonate of ammonia ; so that uræmia would be almost identical with the changes in the blood described in the preceding §.

As uræmia is in most cases connected with disorders of the urinary secretion, and is produced by renal disease, it seems more appropriate to reserve its minute consideration for the sixth volume, which treats of the affections of the uropoietic system.

BILIARY CONSTITUENTS IN THE BLOOD (CHOLÆMIA).

§. 98. Though in the normal condition the blood contains no biliary constituents, or at most but doubtful traces of them, yet in disease we sometimes find large quantities of them accumulated in it, especially the bile-pigment. This accumulation (icterus) is

probably always owing to some obstacle preventing the passage of bile from the liver into the intestines, and thus indirectly causing its resorption into the blood.

The effects of the introduction of biliary matters into the blood are not yet studied in their simple, uncomplicated form ; and cholæmia, as an independent disease, is still involved in profound darkness. For particulars regarding icterus, *vide* under the head of Hepatic Diseases.

FOREIGN BODIES IN THE BLOOD.

§. 99. Many observations made in our own time by Virchow, Meckel, Parkes, Bennett, myself, and others, leave no doubt upon the fact that, in pathological circumstances, foreign bodies may be present in the blood, together with its normal corpuscles. They are larger than the blood-corpuscles, so that, while circulating with them, they stagnate in the narrower divisions of the vascular system, and may thus produce mechanically various injurious effects. Our knowledge of these circumstances is at present very defective ; but the little we know of them is highly calculated to rouse the attention even of practical men to this subject.

The cases in which such foreign bodies occur in the blood, may be arranged in the following classes :—

I. *Fibrinous coagula* or *blood-coagula,* which are formed in the vascular system, in the heart, arteries, or veins, in consequence of phlebitis or of spontaneous

coagulation of the blood, are introduced into the circulation, either entire or in fragments. They stagnate as soon as they reach a division of the vascular system so narrow as to be impermeable to them. This division is, when the coagula are derived from the veins or the right chambers of the heart, a twig of the pulmonary artery ; when from the portal vein, a hepatic twig of the vena portæ ; and in case of their production in the left chambers of the heart, or in an artery (in consequence of atheroma, calcareous degeneration, etc.), a systemic artery. The special seat of their stagnation of course depends upon the size of the coagulum, and upon particular collateral circumstances. The consequences of this obstruction are probably in many cases unimportant and transient, when the obstructed vessel is, for instance, small, and has no great importance, or when the obstructing coagulum soon breaks up, and is dissolved, so that the obstruction disappears with it. In other instances they are very grave, even fatal. This is the case when the obstructed vessel is large, and the chief or the exclusive source of the supply of blood to any particular part, and the coagulum effects a complete closure of it, from the very outset, or after being enlarged by the addition of coagulated fibrin. In this instance, circumscribed gangrene of the affected part is the usual result, or inflammation and suppuration (pyæmic abscesses) are produced around the coagulum, by its mechanical irritation.

A positive *diagnosis* of such conditions is certainly not always possible during life, but is generally so

after death, in the corpse ; and even if it were possible, the coagula could neither be removed before their stagnation, nor after it. The subject has however some practical value, inasmuch as a knowledge of these states will no doubt urge the physician to try every remedy to prevent the formation of any such coagula, or if that is impossible, to guard against their detachment and passage into the circulation, (compare Inopexia, §. 32, as well as Thrombus-formations, Sect : II, §. 54, Hand Book of Special Pathology and Therapeutics).

II. Organised parts (cells) may occur in the blood, which are foreign to its normal composition. There have been observed :—

a. Cancer-cells. Formerly it was more than once maintained, that cancer-cells pass into the blood, and that as they stagnate in the vessels, and there develop themselves further, they give rise to the formation of secondary cancers in various organs. That this really happens at times, I have lately convinced myself in a case which I had an opportunity of investigating together with my colleague, Professor Wernher. On a post-mortem examination of a patient, whose thigh had been amputated for a cancerous tumour, we found coagula in many branches of the pulmonary artery, which had obstructed them, and thus caused pulmonary gangrene. These coagula differed essentially from those of ordinary fibrin, being composed of *cancerous masses.* We likewise found abnormal cells in the blood of various parts of the body, sometimes singly, at other

times united in little clusters. They were generally round, and from two to four times the diameter of the blood-corpuscles, and had, I am convinced, all the characters of cancer-cells. As similar pheno-mena have also been observed by other observers (Bennett, Parkes, Virchow, etc.), I no longer doubt the occurrence of cancer-cells in the blood. Their mode of introduction into it is, however, still obscure. The following modes of explanation are possible :— I. They may pass from topical cancers directly into the veins. II. They may pass from local cancers into the lymphatics, and through them indirectly into the blood. III. They may be developed in the blood itself, either in consequence of a general tendency to the formation of cancer, or because local cancerous tumours propagate the disposition to the formation of the elements of cancer to the blood traversing them, in accordance with the law of analogous formation.

But cancer-cells are far from being found in all cases of cancer. In the bodies of many individuals who died of cancer, I have most carefully examined the blood without discovering any trace of cancer-cells in it.

If the detection of cancer-cells in the blood of the living subject (in blood drawn by venesection) is possible, as I doubt not it is, it will lend important aid to the diagnosis, prognosis, and treatment of the disease. I have therefore thought it necessary to indicate this subject here, while treating of the blood, but its detailed consideration belongs to the section upon Cancer.

b. Caudate cells. These have been observed in the blood by various observers (Meckel and Virchow). In some instances they were found coloured. In a young man, who died of pyæmia, the result of whitlow, I myself found a great number of caudate cells in the blood of various parts of the body, some isolated, others united into large groups and membranous masses. Their mode of origin and signification are not yet evident. Virchow is disposed to assume, that they are developed free in the blood. In the case that I examined, they bore the closest resemblance to the epithelium of the large vessels and the heart ; but this epithelium could not have desqua-mated from putrefaction, as the blood-corpuscles were found to be quite intact. Be that as it may, the subject has certainly a practical importance, inasmuch as such caudate cells may undoubtedly obstruct the vessels, especially if they circulate in the blood in large masses.

Another kind of corpuscles might, it has been maintained, obstruct the more minute vessels on being mixed with the blood; namely, the *pus-corpuscles.* This assumption is, however, decidedly incorrect. The pus-corpuscles perfectly resemble the colourless blood-corpuscles, and cannot be distinguished from them. There is therefore just as little chance of their obstructing the capillaries as of the colourless blood-corpuscles doing so, which is shown to be impossible by cases of leukæmia.

For the detection of the above-mentioned corpuscles in the blood, a simple microscopic investigation

of the latter fluid is usually not sufficient, because foreign bodies present in small quantities are commonly concealed by the immense excess of the blood-corpuscles, and thus elude observation. The following method is more certain in its results: the blood under examination is mixed with so much pure water, (*i. e.*, free from bodies which might produce deception,) as to cause the disappearance of all the red blood-corpuscles, and the mixture is allowed to stand still for some time, until all the solid parts have settled to the bottom. In the sediment thus obtained we find all the foreign bodies as well as the colourless blood-corpuscles; so that even very slight foreign admixtures with the blood can be detected.

In such investigations, special care must be taken that foreign matters, such as epithelial and epidermal cells, etc., do not get mixed with the blood, in the act of taking it from the dead body, or of collecting it during venesection, cupping, etc., and be thus erroneously considered as being met with within the vascular system.

The literature of this subject, which has only been worked at in our own time, is tolerably scattered. The most important facts will be found in :—

Virchow, die Verstopfung der Lungenarterie und ihre Folgen, in Traubés Beiträgen zur experimentellen Pathologie, Part II; *Virchow*, in his Archiv, Vol. II, Part III, and Vol. V, Part I; *Rühle, ibid*, Vol. V, Part II; *Bennett*, on Leucocythæmia (Edinburgh Monthly Journal, 1851); *Kirkes*, in Medico-Chirurgical Transactions, 1853.

III. *Entozoa in the Blood.* The occurrence of entozoa in the blood of animals has been demonstrated beyond doubt by numerous observations. It has also been maintained more than once, that the same phenomenon may be observed in the human blood, by Klenke and others for instance. In more recent times, this fact has been proved in an unquestionable manner by Bilharz of Cairo, who found a species of distomum (distomum hæmatobium) living freely in the blood of the human vena portæ (Siebold and Kölliker's Zeitschrift für wissensch. Zoologie. Vol. IV, pp. 59, 75, 454). It occurred in individuals who were suffering from dysentery, and seemed to stand in a very intimate, perhaps even in a causal, relation with that disease. Considering the novelty of the subject, we need only draw attention here to these observations, and urge on to further investigations, on account of the great practical interest offered by it.

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We shall add here, in the shape of an appendix, some more compound forms of disease, having various relations with the elementary blood-diseases considered in the preceding sketch, but which are still very obscure in many respects.

PUTRID CONDITIONS OF THE BLOOD (SEPTICÆMIA), AND PYÆMIA.

LITERATURE. HISTORY.

§. 100. The diseases, comprised under this head, are very various, and their separation from other affections, theoretically as well as practically, is at present impossible, or purely arbitrary. Formerly it was still more so. A detailed sketch of their historical development would therefore, from the multiplicity and uncertainty of the views existing upon them, be too long for the Hand-Book of Special Pathology and Therapeutics. The same remark applies to the literature of the subject. The most important works and memoirs alone will be mentioned here ; the older writings now possessing perhaps only a historical interest. Should any one, however, wish to be acquainted with the latter, he will readily find the necessary reference to them in the following writings :—

Gaspard, Mémoire sur les maladies purulentes et putrides. Journal de Physiologie par Magendie, Paris, 1822, T. II; *Stich,* die acute Wirkung putrider Stoffe im Blut. Annalen des Charité-Krankenhauses, 1853, Part II ; *Fr. Vacca-Berlinghieri,* Considerazione intorno alle malattie dette volgarmente putride, Lucca, 1781 ; *Aug. Fr. Hecker,* ueber die Natur und Heilart der Faulfieber, Berlin, 1809 ; *Engel,* die Eitergährung des Blutes. Archiv für physiolog. Heilkd. von Roser u. Wunderlich, 1842 ; *Louis Fleury,* essai sur l'affection purulente, Paris, 1844 ; *C. F. Hecker,* ueber

das pyämische Wundfieber in : Erfahrungen und Abhandlungen
aus dem Gebiete der Chirurgie und Augenheilkunde, 1845; *C.
Sédillot,* de l'infection purulente ou pyoémie, 1849; *E. Thiersch,*
pathologisch-anatomische Beobachtungen über Pyämie, nebst kri-
tischen Bemerkungen über die Theorie der Pyämie, 1849; *Bernh.
Beck,* Anatomische Forschungen und physiologische Versuche über
den Einfluss des Eiters, der Jauche und anderer Flüssigkeiten auf
den Organismus bei Einspritzungen in die venösen Gefässe—in :
Untersuchungen und Studien im Gebiete der Anatomie, Physiologie
u. Chirurgie, 1852, pp. 36—79.

§. 101. In the following account we shall bring to-
gether a number of morbid processes which have a
great practical importance, in consequence of their fre-
quent occurrence. Our knowledge of them is at pre-
sent very defective, and the phenomena presented by
individual cases are very various. The distinction
and separation of the individual forms is, therefore,
often arbitrary, and the names employed for them
do not convey any definite idea. These names, which
are used sometimes in a more restricted, and sometimes
in a wider sense, sometimes as synonymous terms,
and sometimes to denote particular forms, are septic
poisoning of the blood, septic crasis, putrid crasis,
septicæmia, and putrid infection; dissolutio san-
guinis; putrid fever, febris putrida; pyæmia, sup-
purative crasis, suppurative fermentation, and infectio
purulenta.

Most cases of disease belonging to this head,
which occur in practice, are very complex in their
nature. To obtain a clear insight into them, it
seems absolutely necessary to resolve each case that
is met with into its proper elements, the more so as

all further advances in the diagnosis of these dis-
eases, are essentially connected with a more minute
study of these elements, according to their causes,
effects and symptoms, than has hitherto been the
case. Under these circumstances, the following
attempt to describe the elementary forms of these
diseases must necessarily be defective, and perhaps
erroneous on many points ; but there seems to be
no other way in which these intricate relations can
be elucidated.

Septic poisoning of the blood and pyæmia may be
indicated as the most elementary forms of these
diseases, which again break up into various sub-
divisions.

1. SEPTIC POISONING OF THE BLOOD
(SEPTICÆMIA).

§. 102. As the blood may be so changed by many
substances introduced from without (by mineral, ve-
getable and animal poisons, such as the poison of ser-
pents, the poison of malignant pustule or " charbon,"
the poison of glanders, etc.), as no longer to fulfil its
functions properly, and thus to produce disease, or
even death ; so may it no doubt be altered by internal
causes originating within the system itself. In such
cases, the blood drawn from the *living* body is found
to be more or less different from the normal standard.
It does not coagulate, or coagulates incompletely into
an unctuous, tarlike mass, has a dirty dark-brown
colour, no longer reddens in the air, and develops
ammonia or sulphuretted hydrogen. Its serum has a

bloody colour, from some of the blood-corpuscles being dissolved in it, and it putrefies more rapidly than usual. We meet with similar changes still more frequently in blood taken from the dead body, so soon after death that they cannot be the result of the ordinary putrefaction of corpses, but must have commenced, or at least the disposition to them has been present, during life. Alterations in other parts of the body are connected with these changes in the blood, especially an infiltration of the dissolved and often discoloured blood-pigment into the tissue of various organs, and its passage into different secretions and excretions, which, together with other phenomena to be subsequently described, must be considered as effects of the change in the blood.

As these alterations in the blood resemble those which are observed when normal blood is left to itself for a longer or shorter period and passes into a state of putrefaction, this condition has been called *putrefaction of the blood, septicæmia ;* and it has been inferred, that in this disease the blood putrefies while within the living body. The few chemical analyses we as yet possess of such "septic" blood, and of actually putrid blood, do not indeed oppose an hypothesis of this kind, but it is very probable that this change in the blood is not the same in all cases, but is very different in nature. This class will therefore be afterwards split up provisionally into various sub-divisions which will have a practical importance, as the treatment must necessarily vary according to the nature of the change in the blood, as well as

according to its cause. In not a single case belonging to this head, do we yet know with sufficient accuracy the mode in which this alteration is produced ; further investigations must be made in two directions, if we wish to be better acquainted with it.

I. No opportunity must be neglected of investigating minutely in all its relations blood so changed, and of studying carefully, not only the alterations in its physical properties, but also those in its chemical composition.

II. The investigations must be conducted in an experimental way with greater care than has hitherto been done. It will not do simply to inject into animals complex, putrid, and ichorous fluids, which are known to produce septic conditions on being brought into contact with the blood, and to study their effects. It is of far greater importance to discover the influence exercised upon the blood by each of the substances which are met with as products of blood-putrefaction or of putrefaction generally, such as ammonia, sulphuretted hydrogen, various organic acids, etc., on its introduction into the system in various ways. Until this shall have been done, we must be satisfied with conjectures, and the following statements upon the nature of the septic change in the blood and its fundamental causes, are to be viewed only as such.

§. 103. The changes which the blood undergoes in septicæmia, are probably different in different cases,

and may perhaps be referred to the following elementary alterations.

1. The blood becomes, as Scherer, myself, and others, have sometimes found, *acid*, from excessive formation of lactic acid (?), which decomposes and dissolves the blood-corpuscles, etc.

2. Carbonate of ammonia is developed in the blood, which decomposes the blood-corpuscles, and dissolves the fibrin and the blood-pigment. (Frerichs' view of uræmia).

3. Sulphuretted hydrogen, or hydrosulphate of ammonia, occurs in the blood.

4. The blood loses its property of spontaneous coagulation, and contains no more fibrin.

5. The blood-corpuscles lose their property of reddening in the air, and cannot perform their respiratory function.

6. The blood-corpuscles are totally or for the most part destroyed, and their colouring-matter is dissolved in the serum, which thereby acquires a red or dirty dark-brown colour.

7. The amount of extractive matters in the blood is augmented, and they are themselves changed in quality.

These just-described elementary alterations in the blood are probably not the only ones that may occur in septicæmia, but they are those which can at present be detected most accurately and by very simple means, and which should, therefore, be investigated in all cases of the disease.

§. 104. The *causes* which produce septicæmia are also still very obscure. We should study and ascertain in each individual case the true fundamental causes, and not the remote, often very accidental, and varying ones. The following may be indicated as examples of the former class.

1. The products of the *normal* metamorphosis of tissue, which ought to be removed from the system as excretions, such as urea, extractive matters, urine, and the lochial fluid, etc., may not be eliminated, but retained in the body, undergoing various changes and decompositions, and re-acting upon the blood, so as to alter its composition. In all these instances, two main points are to be considered : *a*, the causes which retain these excrementitious substances in the body, and thus produce uræmia, cholæmia, etc. ; *b*, the causes which induce or promote the *decomposition* of these retained matters, so as to produce true septicæmia.

2. In consequence of changes in the metamorphosis of tissue, with which we are not yet minutely acquainted, a larger quantity of such excrementitious matters may be produced than in the normal condition, or they may be so modified in their properties as to pass into a state of decomposition while within the body, and with more than usual rapidity. Under these circumstances, septicæmia arises without any such striking suppression or diminution of any of the secretions, as is observed in the first group. It appears that such alterations in the metamorphosis of tissue may occur in hunted animals, and in man after excessive

corporeal or mental labour, after dancing continued for whole days (as I have lately observed), after violent emotions, and probably also often in disease, in many epidemic diseases, for instance, in typhus, tropical fevers, yellow fever, pestilence, puerperal fever, etc., the intimate connection of which is not as yet evident to us.

3. By *local* processes of decomposition, putrefaction, and gangrene, etc., abnormal matters may be produced in some part of the body, which passing into the blood operate injuriously upon it, so as to occasion septicæmia.

4. The cause which excites the decomposition of the blood may be introduced into the system from without, but in a so very imperceptible manner that it is often entirely overlooked. The substances that produce this effect are either such as cause very considerable changes on being introduced into the system in very minute and imponderable quantities, as contagions, miasmata, and bodies in a state of decomposition which, according to Liebig's theory, propagate the same decomposition to the constituents of the body or of the blood, or excite in them a tendency to another kind of decomposition ; or the substances introduced from without operate upon the system for a very long time and repeatedly, and though they produce no effect at the time, yet they may cause important alterations gradually, by their cumulative action. The changes of the blood in chronic poisoning, in the mercurial disease, and in the dyscrasis met with in drunkards, etc., which

in severe cases approach septicæmia, may serve as examples of the latter class of causes.

§. 105. The *results and phenomena* of septicæmia are very different according to its efficient cause, according to the kind and degree of the decomposition of the blood, and according to the complications that are superadded to it ; and their connection is still frequently obscure. The following statements are, therefore, far from being exhaustive of the subject. They are intended only to serve as a guide, and to prompt to further investigations.

In higher degrees of septicæmia, the decomposed blood-constituents pass over into the secretions and excretions. The urine, stools, etc., contain the blood-pigment in a state of solution, and the altered serum with the colouring matter of the blood, is infiltrated into various organs, into the sub-cutaneous areolar tissue, the serous cavities, and other parts of the body.

The nervous and the muscular system are affected. The nervous centres are either over-excited or paralysed, causing the most various symptoms, according to the stage and the individual circumstances of the case ; such as delirium and pains, or prostration and sopor, muscular debility, palsy, subsultus tendinum, etc.

The heart and the circulation are affected, and a small, weak, often unusually quick pulse is the result.

Many secondary changes in the metamorphosis of tissue doubtless occur, though they are as yet perfectly unknown to us. In advanced stages of the disease, a burning hot condition of the skin, *calor mordax*, is always present.

A secondary affection of the intestinal canal is almost always produced. According to Stich, this seldom fails to occur in animals, after the introduction of putrid matters into their blood, even when no signs of its presence can be detected. It takes the form of hyperæmia of the intestinal mucous membrane, especially of the villi and the intestinal glands, which leads to the desquamation of the epithelium, and, when severe, causes the deposit of coagulable exudations, and their ulterior effects, ulceration, etc. Very frequently, the mesenteric glands and the spleen are secondarily enlarged.

In many instances, the substances produced in septicæmia may, on being communicated to other individuals, operate as contagion or miasm, and cause septicæmia* in them, so that the disease assumes the character of an epidemic.

§. 106. The form of septicæmia varies according to its greater or less intensity, and according as it occurs independently, or in connection with other diseases, especially with pyæmia, typhus, etc. The following descriptions will give an outline of some of

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* Compare the interesting statements of Magendie in his Leçons faites au Collége de France. L'union Médicale, 1852. January to October, especially Nos. 70 et seq.

those forms of the disease which are most frequently observed.

1. SEVERE FORMS.

Septicæmia sometimes produces death very rapidly, most frequently by paralysis of the nervous centres, especially of the medulla oblongata. In this case, no other abnormal conditions are found in the dead body besides the change in the blood. Such cases were, and are still viewed as asphyxia, nervous apoplexy, and, if death be preceded by irritation of the motor nervous centres, and by convulsions resulting from it, as convulsions.

In those severe cases in which death ensues less rapidly, the symptoms are generally very complicated and various in their nature. The most frequent and constant among them are febrile disturbances, with excitement of the heart's action, a very quick, irregular pulse, palpitation, chilliness and heat, calor mordax of the skin ; and various nervous symptoms, sometimes indicating excitement of the nervous system (head-ache, delirium, subsultus tendinum, etc.—in short all the characteristic symptoms of febris nervosa versatilis), sometimes torpor of the brain (dulness and a torpid motionless state of the body, passing into sopor and coma—in a word, the symptoms of febris nervosa stupida), and sometimes both combined (deliria mussitantia, coma vigil, etc.). Symptoms of intestinal disease are almost always present; such as vomiting, diarrhœa,

disorder or even entire want of appetite, tongue dry, and with a sooty coating. Tympanitic distension of the abdomen, and enlargement of the spleen, which may be detected by percussion, also exist. Very frequently, apthæ are met with on the tongue, the lips, and in the pharynx.

Symptoms of pulmonary disease are also sometimes present ; such as cough, sibilant rhonchi, and other signs of bronchial catarrh, lobular pneumonia, pleurisy, or pulmonary œdema. These diseases of the lungs however seem to be, according to the investigations of Stich, less the effects of septicæmia than of pyæmia, which frequently accompanies septicæmia. As septicæmia advances, the various excretions often acquire a bloody or dark-brown colour from the decomposition of the blood-pigment —the urine and the stools, for instance, do so. Such sanguinolent secretions also occasionally take place from other mucous membranes, or ecchymoses make their appearance in the sub-cutaneous areolar tissue.

Death often ensues, sooner or later, amidst these phenomena, or the symptoms abate, and the normal condition returns, usually after a very lingering convalescence.

To this class belong many cases of uræmia, typhus, puerperal fever, putrid fever, scurvy, probably also of pestilence, yellow fever, tropical dysentery, and other varieties of tropical fever. A precise distinction of these diseases from septicæmia is at present neither possible, nor useful in practice.

2. MILD FORMS.

These are sometimes simple, sometimes complicated in their character. In the latter case, septicæmia occurs as a result of local suppuration with putrefactive decomposition of the pus, or of local gangrene, and the like. Here the course of the disease is very different, and its phenomena are manifold, inasmuch as sometimes the one and sometimes the other set of symptoms, described under the more severe form, prevails, though with less intensity. The *diagnosis* is much more difficult than in the fully developed form. Very frequently, the physician only *apprehends* that septicæmia may be developed or is impending, instead of being able to detect the disease accurately. In cases of this kind, the *prognosis* is, of course, more favorable. The disease more frequently leads to a favourable termination ; death occurs more rarely ; the duration is shorter ; and the convalescence more rapid.

TREATMENT.

§. 107. In the treatment, the discovery and the counteraction of the *cause* always constitute the chief indication. We should, from the inadequacy of other remedies, direct our special attention to it, even when it cannot be precisely made out but is merely conjectured. If collections of putrid pus be anywhere present, they must be removed as much as possible, or be counteracted by avoiding air

and other means of decomposition of pus. Retentions of secretions, especially of the constituents of the urine, must also be removed (compare uræmia).

If any changes in the blood be discovered, which may be supposed to operate injuriously by themselves, and may contribute to the production of symptoms of septicæmia, we should endeavour to remove them by appropriate remedies. We should, for example, use mineral acids when carbonate of ammonia is present in the blood, and alkalies when the blood has an acid re-action. These remedies, acting according to purely chemical laws, must however be always employed with caution. Their action is seldom so favorable as might be expected from chemical theory ; and they often do more harm than good by their collateral effects.

In many cases, it is advantageous, by exciting the different secretions, to promote the elimination of extractive matters, of urea, etc., and the products of their decomposition, which are accumulated in the blood. For this object we should use, according to circumstances, diuretics, purgatives, (if the intestines have not already been irritated by other causes), and diaphoretics. There are cases, however, in which this mode of treatment proves injurious, as it promotes not only the removal of deleterious matters from the blood, but also the absorption of others into it. We should therefore abandon it wherever we have reason to be apprehensive, lest, by the action of these remedies, putrid matters, ichor and the like, be taken up into the system, and

endeavour to maintain the vessels as full as possible by copious tepid drinks, so as to prevent the absorption of noxious substances, and remove them directly from the body.

In desperate cases, attempts may be made to remove the deleterious matters by causing profuse secretions from the blood, by means of emetics, purgatives, and venesection. This is, however, always a dangerous experiment. The internal and external use of chlorine (of aqua oxymuriatica, liq. chlori) as a disinfectant and antiseptic, may be always tried. Experience, however, shows that this remedy is not so useful in such conditions as might be expected from theory.

Two other important indications besides those already mentioned should in almost all cases be fulfilled. They are as follows :—

I. To remove, or at least to mitigate as far as possible, the most striking symptoms, according to the special rules which apply to them.

II. To support, in severe and protracted cases, the strength of the patient as far as possible, by appropriate food, broths with eggs and wine, and by bark or quinine with acids. In case of collapse, we should resort to the use of stimulants, or in other words, should wash the body with wine, apply sinapisms to different parts of it, and give internally angelica, calamus, wine, ether, musk, camphor, etc. We must however avoid over-stimulation, to which often a fatal collapse so readily succeeds.

II. PYÆMIA.

§. 108. The term pyæmia is employed here in a more restricted sense than usual to denote, in contra-distinction to septicæmia, a disease which is characterised by a tendency to the formation of multiple lobular abscesses, or of the so-called pyæmic foci, in various parts of the body. We shall first consider it by itself, as an elementary disease, and then describe its usual complex form.

The characteristic feature of pyæmia in its limited sense is, as has been just stated, the tendency to the formation of more or less numerous pyæmic foci in different parts of the body. These foci are circumscribed, sometimes large, sometimes small coagula of blood or exudations, which show a particular predilection for the peripheral parts of organs, and frequently appear to be conical, with the base outwards, and the apex inwards. At the outset, they look like firm condensations of the affected parts, and are generally of a dark-red colour, as if the structures had become completely saturated with blood before coagulation took place. Afterwards, they become commonly grey and discoloured, and in most instances soften and form an abscess. This abscess seldom contains good pus, oftener ichor, fœtid and discoloured, whose corpuscles differ essentially from normal pus-corpuscles under the microscope, and resemble the microscopic elements of putrid fibrin or albumen. These pyæmic deposits sometimes disappear without forming abscesses. They are resorbed, shrink, undergo a fatty

or calcareous degeneration, totally or partially, and leave cicatrices behind, or give rise to the formation of concretions.

These pyæmic foci are formed most frequently in the lungs, and but seldom in other organs, in the spleen, liver, and kidneys, or in the sub-cutaneous areolar tissue, in muscles, and in the brain. According to Sédillot, 99 per cent. are found in the lung, $\frac{1}{12}$ of a per cent. in the liver and spleen, $\frac{1}{15}$ in muscles, $\frac{1}{20}$ in the heart and the areolar tissue, and a still small number per cent. in the kidneys and the brain, etc. They are sometimes numerous, occurring in several organs at the same time ; in other cases, however, they are fewer in number. In connection with them, we occasionally meet with purulent or ichorous effusions in the serous cavities, in the pericardium, the pleura, and the peritoneum, or more especially in the synovial membranes. Vesicles, pustules, and aphthæ are also sometimes observed upon mucous membranes.

The further effects of these pyæmic foci are either local, such as functional disturbance of the affected parts, their destruction by softening and gangrene, and œdema of the surrounding structures ; or general, produced by the introduction of ichor and decomposed matters from the abscesses into the blood. These latter symptoms are the same as those of septicæmia, namely, fever with a hectic or a dynamic character, and, in severe cases, perfect septicæmia and death.

§. 109. In ascertaining the true theory of pyæmia, it is a matter of great importance not to seek to explain all cases of it by one and the same cause, but to concede from the very outset the possibility of pyæmic foci being produced in various ways, and to consider each of these possible ways by itself.

1. Pyæmic foci may arise from the introduction of foreign bodies into the blood, which circulate with it, but which cannot, on account of their size, pass through the narrow portions of the vascular system, in which they consequently stagnate. As these foreign bodies disintegrate, the obstruction may be again removed, and disappears without leaving any trace ; but they may also irritate the surrounding parts, so as to cause coagulation of the blood, exudation and inflammation, thus forming a pyæmic focus.

Such foreign bodies have been shown in an unquestionable manner to be causes of vascular obstruction, and of pyæmic foci (vide Foreign Bodies in the Blood, §. 99). They are rarely cancer-cells or caudate cells, but in by far the greatest number of cases coagula of blood or fibrin, formed in the large veins or arteries, or in the heart, from which fragments are detached and introduced into the circulation. This detachment occurs most frequently, when a coagulum of blood so projects into the cavity of a vein, as to be constantly washed by the current of blood which enters from a collateral branch. It is also

promoted by the co-existence of septicæmia ; the coagula being, in putrid blood, more rotten, fragile, and crumbling more readily into pieces (Stich). If these coagula originate, as usual, in the veins or the right chambers of the heart, they stagnate in the pulmonary arteries when they are large, and in the pulmonary capillaries when they are small ; if they be produced in the portal vein, they are obstructed in the liver ; and, lastly, if in the left chambers of the heart or in the arteries, the pyæmic foci are then formed in some part of the capillary system of the greater circulation. The more frequent occurrence of pyæmic foci in the lungs may be easily explained by the fact that the coagula are generally derived from the veins. And the occasional existence of numerous pyæmic foci in different parts of the body, in addition to those in the lungs, is, apart from the reasons to be subsequently adduced *(vide* under 2), probably owing either to the stagnation of the larger coagula alone in the lungs, while the smaller pass through the wider pulmonary capillaries, but are obstructed in the narrower systemic ones, or, as Stich supposes, to the gradual enlargement of the coagula, during their circulation with the blood, by the fresh deposit of coagulated fibrin upon them, till at last they attain a size which prevents their further progress, and causes them to stagnate.

It has often been maintained, most strenuously by Sédillot in our own time, that pus-corpuscles, being introduced into the blood, might also stagnate in the capillaries, and produce pyæmic foci precisely in the

same manner as the foreign bodies named above. This view, however, is decidedly incorrect. This is evident from the numerous experiments of Beck, who has repeatedly injected pus-corpuscles into the blood without producing pyæmic foci, and still more from the phenomena of leukæmia so frequently observed in the present day *(vide* §. 23, 27,) in which an immense number (billions) of corpuscles, apparently quite identical with those of pus, or, at any rate, exactly resembling them in size, form, and properties, circulate with the blood without stagnating anywhere. *Larger lumps* contained in pus, such as fibrinous flakes, and pus-corpuscles dried together, etc., may however, of course, stagnate and mechanically give rise to pyæmic foci.

It is very probable that the pyæmic foci are not always produced in the manner mentioned above, by a mechanical obstruction of the vessels by foreign bodies. They are frequently present, without the most minute examination detecting any trace of foreign bodies in the blood, which might have mechanically blocked up the vessels. In such cases, we must take the aid of other more or less probable hypotheses in the explanation of the pyæmic abscesses.

2. The blood, or rather a portion of its fibrin, acquires a tendency to coagulate (Inopexia, *vide* §. 32.) This produces coagula in different divisions of the capillary vascular system, and consequently pyæmic foci.

This event corresponds to the spontaneous obliteration of the veins (phlebitis adhæsiva) which so

frequently occurs ; the only distinction between them consisting in the occurrence of coagulation in the large veins in the one case, and in the capillaries in the other.

Regarding the causes of this inopexia, which is of such great importance in the production of pywmia, we as yet know very little. Numerous observations and direct experiments* lead to the belief, that the admixture of pus with the blood causes, or at least promotes, inopexia. We cannot however at present precisely determine how it does so, or to which of the constituents of pus the effect is mainly due. The cases of leukæmia, in which numerous corpuscles, exactly similar to those of pus, and by no means distinguishable from them, are found in the blood without the occurrence of inopexia, render it probable that the coagulation of the blood does not depend upon the *pus-corpuscles.* But the pure liquor puris seems likewise not to cause inopexia, which is therefore, in all probability, produced by certain alterations in the pus, which require to be fully elucidated by means of further investigations. A more careful study of these is very desirable, on account of their great practical importance.

3. As the occurrence of a solitary abscess in any part of the body does not necessarily indicate any alteration in the mass of the blood, so also a tendency

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* Compare *Millington,* Experimental enquiry into the effects of various animal matters injected into the blood.—Edinburgh Monthly Journal, 1851, p. 486 ; *H. Lee,* purulent infection of the blood.—Medical Times,1852, April, p. 401.

to the production of multiple abscesses may perhaps exist (dependent on the state of the nerves or coats of the vessels) without an alteration of the blood. On these grounds, it has been attempted to explain the occurrence of multiple abscesses, by assuming a peculiar tendency to them, in other words, by a purulent diathesis. This theory must however be very imperfect, as long as we are unacquainted with the conditions and causes of the formation of abscesses generally. We mention it here only to indicate the existence of other causes of the formation of pyæmic foci besides those already stated, which should not be omitted in a comprehensive consideration of the subject.

Various other modes of origin of pyæmia besides those described above, have been assumed, some of which may certainly be shown to be incorrect. Of this nature is the hypothesis that pus-corpuscles, introduced into or produced in the blood, may by accumulating at certain spots directly form pyæmic foci. This is contradicted by the often observed fact, that the pyæmic foci never contain pus from the very beginning, but always commence in a solid deposit (coagulated fibrin or coagulated blood), which is afterwards transformed into pus-corpuscles, or still oftener into indistinct molecular fragments *(vide supra* § 108*).* The view, maintained by many authors, that pus-corpuscles might break up into minute elements, outside the vascular system, and so penetrate the vessels, and become pus-corpuscles again by a reunion of the molecules, almost precisely in

the same way as a house may be pulled down, and out of its materials another built again at some other spot, must also be entirely rejected on physiological grounds. Further, according to the preceding account, the so often mooted question, whether pus-corpuscles occur in the blood in pyæmia, seems to be quite unimportant in the theory of the disease, especially when taken in connection with the entire insufficiency of the means hitherto proposed of distinguishing them from the colourless blood-corpuscles, as long as we do not succeed in showing with greater certainty than has hitherto been done, that the pus-corpuscles do really play a part in the formation of pyæmic foci. The same remark also applies to the explanation of the mode in which the pus-corpuscles are introduced into the blood, etc.

TREATMENT OF THE ELEMENTARY PYÆMIC PROCESS.

§. 110. The treatment of the complex disease, as it occurs in practice, will be subsequently mentioned. Here we shall only make a few remarks upon the rational treatment of the elementary pyæmic process, so far as it is at present possible. Its chief indications are—*a.* to prevent the formation of pyæmic foci ; *b.* to cure them ; *c.* to mitigate their effects.

a. To fulfil the first indication, the causes of the pyæmic foci must be avoided or removed. This can at present be done in but a very imperfect manner, by preventing the entrance or the resorption of pus into the blood as far as possible, and by counteracting

inopexia (by means of nitrate of potash, and alkalies?). If coagula have already formed, we should take the greatest possible care to prevent their detachment and introduction into the circulation, by depressing the latter, enjoining perfect rest, and if possible, by compressing the vessels which the coagula must pass through to get into the circulation.

b. Our art can do little for the cure of pyæmic foci that have already formed. The chief indications are always to afford the system the necessary time for a natural cure, by means of proper diet and remedies, regulated according to general principles; and to avoid disturbing noxious agents as far as possible.

c. The evil effects of pyæmic foci are either *local* or *general.* To the former class belong material changes in the surrounding structures, such as hyperæmia, œdema, gangrenous softening, and functional disorder of the affected parts. These effects differ according to the nature of the case and the part affected, and their treatment must be regulated by special indications. The general consequences are chiefly produced by the resorption of ichor from the pyæmic foci and the consequent poisoning of the blood. They should be treated according to the principles laid down under the head of Septicæmia.

PYÆMIA AS A COMPOUND DISEASE (SEPTICOPYÆMIA.)

§. 111. In the majority of cases, pyæmia in the widest sense, is a very complex disease, in which the symptoms of septicæmia are usually combined more or less

with those of the true pyæmic process. In some instances the pure pyæmia is the primary disease, and septicæmia is of later origin, and is produced by the resorption of ichor from the pyæmic foci. The two diseases, however, are often combined from the very beginning, and occasionally septicæmia favours the production of pyæmia, as the coagula produced in septic blood are softer and more fragile than usual, and therefore pass more readily into the circulation.

The individual cases present so great a multiplicity of symptoms, that a detailed description of them would only create confusion. The following sketch will therefore be restricted to their most frequent and important features. For facility of review, we shall arrange the cases in two groups, which do not, however, occur in nature quite separate ; namely, pyæmia as an independent disease (the more severe form), and pyæmia as an accompaniment of other diseases (the milder form).

1. PYÆMIA AS AN INDEPENDENT DISEASE—MORE SEVERE FORMS.

§. 112. The forms of pyæmia belonging to this class, are most frequently produced by local suppuration, either following amputations and other surgical operations, or occurring spontaneously, especially in internal parts from which there cannot be a free discharge of pus. Thus, they are caused by internal and burrowing abscesses, suppurative articular inflammation, gangrenous abscesses (carbuncles), phlebitis, periphlebitis,

lymphangoitis, puerperal inflammation of the uterus and its surrounding structures, endocarditis, and arteritis. Their occurrence is promoted by all circumstances which further the decomposition of the pus that is formed—by the action of air upon it, by the admixture of urine and other excrementitious substances in a state of decomposition with it, by uncleanliness,—or which augment the resorption of the decomposed pus, and also by a vitiated condition of the atmosphere (miasmata and contagions.)

The disease often commences with a fit of shivering, which is sometimes repeated. This is followed by febrile heat, or by an alternation of chilliness and heat.

The pulse is accelerated, and, at the height of the disease, very rapid, small, and soft.

The patient feels languid and exhausted, suffers from headache, excitement or depression of spirits, and sleeplessness. At an advanced stage of the disease, cerebral excitement (delirium) ensues, which is succeeded by depression passing into coma.

The appetite is diminished, and the thirst increased. Intestinal disorders are generally present, such as irregular stools, and sometimes fœtid purging. An enlargement of the spleen may almost always be detected by percussion. At an advanced stage, the mucous membrane of the alimentary canal is often covered with aphthæ, and vomiting occurs. The tongue, lips, and nostrils become dry, and acquire a fuliginous appearance.

In most cases, disorders of respiration take place ; viz., cough, expectoration, dyspnœa, and other

symptoms of lobular pneumonia, often of pleurisy, œdema and gangrene of the lungs.

The skin is discoloured, being yellowish or fawn-coloured, apparently icterous, and is often hot and dry. Sometimes profuse perspiration takes place, which is frequently accompanied by the miliary eruption. Erysipelatous affections are often superadded, with infiltration of serum under the skin, readily leading to diffuse suppuration in the sub-cutaneous areolar tissue (pseudo-erysipelas phlegmonodes).

Sometimes effusion of pus takes place into the joints.

Local suppuration is modified under the influence of the pyæmic fever, and a bad, thin ichor is formed instead of good pus.

In severe cases of pyæmia, the *prognosis* is generally unfavorable, always doubtful. Death often ensues, either rapidly amidst the symptoms of typhous or septic fever, sometimes very rapidly (pyæmia fulminans), or slowly from hectic fever. In case of recovery, the convalescence is generally slow, as the cure of the pyæmic foci, and the removal of the septic change in the blood are gradually effected. The greater or less intensity of the pulmonary affection and of the decomposition of the blood, forms our chief guide in the prognosis.

2. PYÆMIA AS AN ACCOMPANIMENT OF OTHER DISEASES—MILDER FORMS.

§. 113. Symptoms of pyæmia frequently occur in the course of other diseases, especially of such

as are connected with suppuration, in suppurating wounds, for instance, in small-pox at the stage of suppuration, in softened tubercles, in pulmonary blennorrhœa with bronchial dilatation, in dysentery, etc. They are similar to those of the more severe form, only milder and less marked. According to the peculiarity of the case, sometimes one and sometimes another set of symptoms is most conspicuous. The prognosis here is more favorable. Yet death may take place by an increase of the symptoms, or in consequence of the long duration of the disease, and the production of hectic fever.

TREATMENT.

§. 114. The treatment of compound cases of pyæmia must generally be guided by the same principles as have been laid down for the treatment of septicæmia and of pyæmia in its more restricted sense.

The prevention of the disease, and the removal of the cause always deserve our chief consideration.

As pyæmia generally arises from a local suppurative process, the purulent collections that are present must be attended to as much as possible. We should take every care to promote the free discharge of pus, and prevent its accumulation and decomposition, by washing out, injecting, and carefully cleaning the abscesses, in case of suppuration of accessible parts, and in internal suppuration, as in pulmonary tubercles and pulmonary blennorrhœa,

by promoting expectoration, etc. We should also endeavour to act powerfully upon the pyogenic surfaces, and prevent the resorption of pus as much as possible. These objects are fulfilled, according to circumstances, by the topical application of cinchona, alum, tannate of lead, charcoal, tincture of iodine, nitrate of silver, or of the actual cautery. Further, the vascular system should always be maintained as full as possible by copious drink, to prevent the resorption of ichor. In appropriate cases, attempts should be made to compress the veins and lymphatics that are concerned in the latter process. We should also avoid drastic evacuants, as they promote absorption.

In addition, we should provide for pure air, and try to keep off all miasmata and contagions, or destroy them by means of chlorine-fumigations, etc.

If necessary, we should remove the suppurating parts by amputation as early as possible.

Various specifics have been recommended for the prevention or cure of pyæmia ; yet none of them can be depended upon. For example :—

Chlorine (chlorine-water). Internally, this remedy is seldom of much use, as it can be employed in small doses only, which are converted into hydrochloric acid long before they can be introduced into the blood, and produce an antiseptic effect upon it.

Tincture of Aconite, which has been especially recommended by Tessier, is uncertain in its action, with me, at least, it has always failed.

Carbonate of ammonia (eau-de-luce) perhaps counteracts inopexia, but it is not a safe remedy in large doses.

When the disease has occurred, we should attend to the cause, if it be still in operation, and in addition fulfil the following important indications :—

1. To excite the secretions, in order to remove as far as possible the deleterious matters that are present in the blood. This should be done, however, only when we are certain that it will not produce increased resorption of ichor, etc. (*Vide* p. 107).

2. To support the strength of the patient as much as possible, so that the system may have time for the cure of the pyæmic foci. For this object we should provide nutritious food, and give bark with acids, and, if necessary, stimulants, wine and the like.

3. To treat the most important symptoms as carefully as possible, and to have the general state of health constantly in view in the treatment of the disease of the lungs, the intestines, or the skin, and of the fever, etc.

SCORBUTUS (SCURVY).

§. 115. In the middle ages, scurvy was very frequently observed, and occupied much the attention of physicians. In our own time, however, it has become very rare, and generally occurs, some sea-voyages excepted, almost exclusively in some pro-

vinces of Russia.* It, therefore, possesses now little practical interest. As we know nothing certain regarding its true nature, its theoretical interest is also very small, the interest excited in recent days by a series of discussions which took place upon this disease in the Academy of Paris, in the year 1847, having been very transitory.

Lind's Treatise on the Scurvy, dated 1752, has long been the main work upon the subject. Of more recent works the following may be mentioned :—

Hr. von Samson-Himmelstiern, Beobachtungen über den Scorbut, 1843. Waldem. v. Himmelstiern in Häsers Archiv. V. 488; *Cejka* in Prager Viertelschr. 1844; *A. Fauvel,* mém. sur le scorbut observé à la Salpetrière en 1847, etc. Archiv. génér de med. 1847, Juillet; *A. Lilienfeld,* Erfahrungen über den Seescorbut, gesammelt auf einer Reise um die Welt. Casper's Wochenschr. 1851. Nos. 1. 2. 3. For particulars touching the history and literature of scurvy in our own time, *vide* Russian Medical Chronicle, 1851, No. 32.

§. 116. By scurvy is understood a disease which seldom occurs in an acute form, being generally chronic in its character. Severe cases of it agree in many respects in their symptoms with septicæmia, and are regarded by some as a degeneration of it.

We shall in the first place give a description of its course and symptoms as observed in highly developed and perfectly characteristic cases of the disease.

* In Russia 260,444 individuals were attacked with scurvy in 16 Governments, in the year 1849, of whom 60,958 died.—Russian Medical Chronicle, 1851, No. 1.

Scurvy appears generally in a gradual manner. We therefore observe, in the majority of cases, a series of symptoms which precede the outbreak of the actual disease (preliminary stage). The patient feels out of sorts and melancholy, complains of weakness, languor, and slight fatigue, especially in the inferior extremities, has a great tendency to sleep, and a pale cachectic appearance, with blue haloes around the eyes. The pulse is slow and soft, the appetite diminished, and there is often, though not always, a longing for fresh vegetables and acidulous food or drinks. The bowels are generally torpid ; the urine is scanty ; the skin dry.

These symptoms gradually lead to the development of the disease itself (first stage of most authors). We generally observe at this time a peculiarly striking alteration in the *gums*. These are of a bluish colour and swollen, and bleed on the gentlest touch. There is a bad taste in the mouth, and a fetor in the breath. At the same time the debility increases to such an extent, that the patient can scarcely maintain himself erect. The extremities become the seat of tearing, dragging pains, which are often severe, especially in the joints. Spots of ecchymosis also appear, first on the lower extremities, and then sometimes over the whole body, from the size of a lentil to that of a dollar or more. These look, at the outset, bluish-red, in severe cases even blackish, but afterwards undergo the changes of colour that are known to occur in extravasated blood. Epistaxis often supervenes.

If the disease lasts long, and increases in severity, its symptoms become of course aggravated (second stage of most authors). The exhaustion and powerlessness becomes so great, that fainting takes place on the slightest exertion. The gums pour out a sanious, fetid ichor ; the teeth become loose, and drop ; and the breath becomes highly fetid. The scorbutic spots increase, and the epidermis is often raised into vesicles, which are filled with an ichorous fluid, and pass into superficial ulcers. Deeper ulcers with fungous, readily bleeding granulations, are sometimes produced by the bursting of the ecchymoses in the sub-cutaneous areolar tissue. The pains in the limbs and joints become more intense. The joints and the bones are swollen. The appetite is entirely wanting, the longing for acidulous, cooling things being all that is left. The constipation which existed at the previous stage now gives place to thin, ichorous, bloody purging, accompanied by colic-pains. The region of the spleen seems tumid, and an enlargement of that organ may be detected by percussion. The tendency to epistaxis is increased. Hæmorrhages or sanguineous secretions take place from the conjunctiva of the eyes, from the organs of respiration, from the stomach (by vomiting), and from the uropoietic system (bloody urine). The pulse becomes smaller, softer, and weaker, without being however much accelerated ; and palpitation of the heart, and dyspnœa passing into fits of asthma are produced.

A higher stage of the disease (third stage of most authors), which has usually death for its consequence, is generally marked by the occurrence of large extravasations of blood and exudations of a bloody serum into important internal organs, (scorbutic effusion into the pericardium, the pleuræ, the lungs, the brain and its membranes [scorbutic apoplexy], etc.), which cause a fatal termination, either rapidly, or gradually through increasing weakness and hectic fever.

On post-mortem examination, we find the blood fluid, and of a dark colour ; the coats of vessels and the lining membrane of the heart reddened by dissolved blood-pigment ; sanguineo-serous exudations in the pleuræ, the pericardium, the peritoneum, the membranes of the brain, and the articular capsules ; the muscles discoloured, ecchymotic, and soft : and lastly most of the internal organs, the spleen, liver, and kidneys, for instance, and the bones, full of dissolved blood and ecchymotic.

§. 117. *Varieties. Causes.* Scurvy is not always so severe as has been described above. In many cases only a few of the slighter symptoms are present, such as relaxation of the gums, scorbutic ecchymoses in the sub-cutaneous areolar tissue, etc.

The duration of the disease is short perhaps in those cases alone which have a rapidly fatal termination. It however commonly lasts for several months, and in severe cases, the convalescence is very tedious, especially when material changes are present, such as ulcers, articular affections, enlargements

of bone, etc., which require a long time for their cure, even in the most favorable circumstances.

Formerly scurvy was distinguished into *sea-scurvy* and *land-scurvy*. They are, however, both the same, if we set aside their mode of occurrence. *Sea-scurvy* was formerly extraordinarily frequent. It has, however, become so rare at the present day as to occur only exceptionally, during very long sea-voyages, under peculiarly inauspicious circumstances. Its main cause is regarded to be a *long abstinence from fresh vegetable food.* Its occurrence is promoted by moist cold,* bad, putrid air, bad drinking-water, rotten, rancid meat, by depressing affections of the mind, and the abuse of spirituous liquors. The shorter duration of sea-voyages, and the better supply of provisions in ships are the cause of its rarity at the present day.

In former times when it occurred more frequently, *land-scurvy* was produced by causes similar to those of sea-scurvy, by bad food in years of scarcity and in besieged towns, together with cold, damp, and the depressing passions. Yet many of the epidemics of scurvy, described by the earlier writers, were not true scurvy, but typhous or septic fever. At present, it occurs in most countries of Europe, perhaps only as a sporadic disease, in drunkards, after the excessive use of many medicines, such as alkalies, nitre and mercurials, and in those individuals who, in

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* Yet according to Lilienfield, moist *heat* is said to favour the outbreak of scurvy more than cold.

addition to immoderate hardship, are put upon bad rotten food ; or it appears in the form of small epide-mics in prisons and badly maintained hospitals, espe-cially in very old persons. We have an instance of this in the small epidemic described by Fauvel, which attacked only women of from 69 to 80 years old.

§. 118. A *theory of scurvy* which would explain its symptoms even partially, cannot be given at present. It is true that a change in the blood has almost universally been assumed to be the cause of the disease ; but nobody has demonstrated in what that change consists. A deficiency of fibrin in the blood (hypinosis) has indeed been regarded as the cause of scurvy by more recent, especially French pathologists, though doubtless incorrectly. For in some cases of the disease, the analysis of the blood has shown, not only no diminution, but even an augmentation of the fibrin. Becquerel and Ro-dier are therefore not justified in distinguishing hy-pinosis, at the present day, by the name "scorbutic state" (*vide* Hypinosis §. 31).* Some, (Magendie, Bec-querel and Rodier) seek the essence of the scorbutic change of the blood in an excess of soda, by which the amount of fibrin is also diminished ; others (Gar-rod for instance,) in a diminution of the salts of potash. These hypotheses, however, stand in need of proof. And so long as we know nothing positive regarding the nature of this change, it is useless to

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* Compare *Fauvel,* op. cit.; *Andral,* Comptes Rendus, T. xxiv, p. 1155; *Marchal de Calvi,* Comptes Rendus, T. xxv, p. 275 ; *Becquerel* and *Rodier,* Gaz. Méd. 1847, No. 26, and 1852, No. 31.

pretend to explain its occurrence chemically by certain alterations in the mode of nutrition. It is surely just as useless to devise hypotheses explaining the mode in which the swelling of the gums, and the scorbutic ecchymoses, etc., are caused by the unknown change in the blood. We cannot expect to explain these symptoms till the foundation of a more precise knowledge of the scorbutic alteration in the blood has been laid by numerous analyses of the latter fluid, having reference to all its constituents.

As long as the true nature of scurvy is veiled in obscurity, its *diagnosis* will often be doubtful. When it is severe, its separation and distinction from pyæmia is sometimes difficult. When it occurs in a mild form, the same remark applies to its diagnosis from purpura and morbus maculosus, which two diseases are by some classed quite arbitrarily with scurvy, by others separated from it, and described as independent diseases.

The *prognosis* depends upon the stage of the disease, and upon whether it is possible to remove its causes, and to transfer the patient into better circumstances. In difficult cases, especially at the second and the third stage, it is doubtful, and even unfavorable ; in slight ones, and under favorable circumstances, it is, however, more hopeful. In old drunkards, it is generally bad.

§. 119. *Treatment.* Where there is reason to apprehend the occurrence of scurvy, as in long,

troublesome sea-voyages, prophylactic measures are necessary for the prevention of the disease ; namely, providing a sufficient amount of fresh vegetables (preserved in hermetically closed tin-boxes), sourcrout, lemon-juice, wine, fresh water, fresh air, etc.

When the disease has broken out, the regulation of the diet is the main indication. We should give, if possible, fresh vegetable food, cresses, horse-radish, sorrel, scurvy-grass, and fresh acidulous fruits, oranges, citrons, currants, apples, sour cherries, and if these can not be had, sour-crout. Only fresh meat should be allowed to be taken, and the use of salted or smoked meat, herrings, cheese, etc., should be prohibited. As drink we should give lemonade, acidulous wines, and good beer in small quantities. The cheering up and exaltation of the spirits deserves our special consideration.

The diet should be aided by appropriate medicines, by infus. calami, decoct. cinchonæ with mineral acids, and by aromatic tonic bitter remedies, as gentian, cortex aurantiorum, etc. When diarrhœa is present, we should administer calumba, sulphate of iron, and muriate of iron. If the bowels be constipated, we should avoid the employment of such purgatives as may produce a fatal collapse, and give only gentle aperients, rhubarb for instance, or restrict ourselves to the use of clysters.

Astringent gargles are useful for the affection of the mouth ; such as decoction of cinchona with myrrh and sulphuric acid, spirit of scurvy-grass, and solution of alum. In severe bleeding from, and ulcer-

ation of the mouth, honey of roses and hydrochloric acid should be applied with a brush.

The scorbutic ecchymoses should be treated with cataplasms of vinegar, pyroligneous acid, and dilute mineral acids ; and the ulcers with fomentations of decoction of cinchona with sulphuric acid.

When the convalescence is slow and weakness persists, a change to a milder climate is useful.

THE END.

OPINIONS OF THE PRESS.

"It gives an excellently condensed account of Blood-diseases, and deserves to be extensively known throughout Great Britain and its dependencies by the medium of the English language. It displays a profound acquaintance, on the part of the author, with Chemistry and Pathology, and is distinguished, moreover, by great powers of observation, and an absence of vague speculation, into which some writers on the Diseases of the Blood have been too often led.

"The translation does very great credit to Mr. Chunder Coomar Dey, who is, we believe, a native of India, and who is a Graduate of the Medical College of Bengal. He apologizes, in a very modest preface, for the imperfections of his attempt to Anglicize the work of the distinguished German pathologist : but his apology is hardly necessary, as the translation is throughout very correct, and might have been written by an English author. We are happy to notice Mr. Chunder Coomar Dey's effort in such terms of approbation, and hope that it will serve the double purpose of extending the ˙views of Vogel throughout the Profession in India, and of stimulating the Native Students and Graduates in Medicine to similar praiseworthy attempts."
—The *Medical Times and Gazette*, London, September 20, 1856, p. 296.

"This is a very satisfactory translation of the article, "Störungen der Blutmischung," constituting the fourth section of the first volume of the valuable "Handbook of Special Pathology and Therapeia," edited by Virchow, and now in course of publication in Germany. It is most creditable to the Bengal College, and to Dr. Dey in particular, that an Indian presidency should be the first to present the English reader with a translation of the valuable monograph of Vogel, which "contains a comprehensive, lucid, and accurate exposition of the Blood-diseases, and affords a clear and definite idea of the present state of our knowledge regarding them."—The *Lancet*, London, October 11, 1856, p. 410.